HISTORICAL PERSPECTIVES:

A REVIEW AND EVALUATION OF 76 STUDIES OF THE DEFENSE RESEARCH ENTERPRISE, 1945-2015

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This report summarizes recommendations from 76 prior studies of the Department of Defense Research Enterprise. A brief summary and evaluation of each study is provided, and recommendations are grouped according to management areas. Enduring themes, relevant historical detail, and prominent policy tensions are emphasized. Views expressed in summaries and evaluations represent only those of the author, and do not represent the views or policies of the United States Government or any of its departments or agencies.

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PREFACE

On February 18, 2016 Under Secretary of Defense for Acquisition, Technology, and Logistics Frank Kendall provided four research questions for the Defense Science Board (DSB) Task Force on Defense Research Enterprise Assessment:

1) *How well do the defense laboratories respond to the needs of the Department?*
2) *What mechanisms exist to refurbish and recapitalize Department of Defense labs, and how do these mechanisms compare with other Government, academic, international, and industrial counterparts?*
3) *How well does the Department attract, recruit, retain, and train its workforce to remain technically current and flexible to respond to emerging national requirements?*
4) *Does the appropriate balance exist in each service between service control and laboratory director discretion so as to maximize mission effectiveness?*

The defense research enterprise encompasses a network of in-house laboratories, non-profit research facilities, industry and university defense research, and collaborations with other Agencies and friendly governments. In-house laboratories include "62 Department laboratories across 22 states and the associated workforce of over 65,000 employees, of which approximately 36,400 are degreed scientists and engineers." The DoD Laboratory Enterprise has three main objectives: 1) Generating innovation to increase capabilities and reduce costs of current military capabilities; 2) Supporting the DoD Smart Buyer mission throughout the acquisition lifecycle (i.e. "the ability to collaborate with contractors and assess the defense value of private sector technological developments"[i]; and 3) Eliminating technology surprise while creating technology surprise that enables strategic overmatch on current and future battlefields..

Statement of Task

The Task Force's Executive Secretary, Dr. Jagadeesh Pamulapati, directed the author to compile a list of historical DSB report recommendations (1956-2015) to assist the Task Force in pursuing the Terms of Reference. The present report provides summary evaluations of these reports and sorts historical recommendations in the following categories: Administration / Organizational Structure; Budget; Contracting; Congressional Relations; Education; Facilities / Equipment; Further Studies; Manpower / Personnel; Public Relations; and University-Industry-Service Interaction.

In addition to 23 DSB reports, 53 additional studies (1945-2015) were selected from a digital bibliography of DoD laboratory management studies developed by former Assistant Secretary of Defense (Research & Engineering) Honorable Zachary Lemnios, expanded by Deputy Assistant Secretary of Defense for Research Dr. Melissa Flagg, and maintained by Defense Technical Information Center personnel Carol Jacobsen and Phyllis Ovsiew through *DoDTechipedia*. Defense Science Board personnel provided the author with lists of recommendations for three of the 76 reports.

The recommendations listed in this report closely match the wording used in the original reports, except in cases where clearer formulations were apparent. The summaries introducing each report are intended to convey enduring themes, historical context, and the rationales driving key recommendations. In cases where the historical value of a report is not tied to specific recommendations but rather to features of methodology or broader context, recommendations are omitted or briefly mentioned in the summary itself.

EXECUTIVE SUMMARY

The U.S. Department of Defense has many ongoing initiatives to improve the responsiveness of its organizational components and external partners to Department needs and national interests. Future of the Force initiatives, Better Buying Power 3.0, the Third Offset Strategy, Defense Innovation Unit X: the list could go on. These efforts are designed to improve responsiveness to a broad range of potential threats and conflict scenarios while improving the Department's long-term responsiveness to budget uncertainty and legislative pressures, unpredictable technological change, environmental complexity, volatile cultural interactions, economic and geopolitical risk. DoD not only responds to these conditions, but actively shapes them.

This report collects historical perspectives from 70 years of official reports and commissioned studies assessing the defense research enterprise, with the expectation that historical recommendations for improving defense research enterprise management can inform, expand, and improve deliberation on today's challenges and policy options.

The most profound insights gleaned from historical analysis will not come as a surprise to many:

1. DoDs actual future needs are not likely to be the same as the ones it currently anticipates.
2. DoD's limited capacity to collect, monitor, and evaluate complex laboratory management information limits its ability to clearly distinguish positive and negative effects of implemented policy changes. As a result, contentious policy prescriptions are often not properly tested.
3. Defense laboratories' responsiveness to Department needs depends upon the capacity of in-house scientists and engineers (S&Es), lab directors, and DoD leaders to absorb and utilize an exponentially growing body of scientific knowledge production and technological innovation increasingly produced overseas. This knowledge management problem outpaces DoD's capacity to respond to the problem.
4. Very good ideas for improving laboratory management in a given report are very often not tested and implemented, and are frequently dismissed without good reason in other reports. For example, the recommendations offered in the 1970s and 1980s for properly funding recapitalization and refurbishment (discussed below) are identical to those on offer in 2016.
5. Policy recommendations with significant long-term impacts on the Smart Buyer function and performance of inherently governmental responsibilities are often put forward in the demonstrable absence of adequate management information that would justify the confidence with which those recommendations are asserted. For example, the reports claiming that large in-house laboratory personnel reductions and dramatically increased contractor to in-house personnel ratios will not adversely affect Smart Buyer capability are the very same reports chastising DoD for not having adequate management information to assess how well its personnel are currently performing these functions.

While reports evaluated here are consistent across decades in stating that DoD must improve its knowledge management infrastructure in order to properly assess and improve the performance of its research enterprise, this lack of institutional assessment tools has not been catastrophic, and will not become catastrophic in the foreseeable future. The Department continues to faithfully execute its constitutionally mandated national security mission. Several factors are likely to nudge the Department

toward dramatic improvements in the collection and utilization of management information: public-private partnerships, inter-agency collaboration, and joint research with friendly governments are likely to expand and proliferate alongside increasingly strong democratic demands for resource accountability and civilian oversight.

When a wave of Vietnam-era social unrest elicited strong Congressional concerns for civilian oversight in 1968, DoD's acting Director of the Office of Laboratory Management Donald MacArthur assured the public that the Department of Defense was responsive to their concerns: "An important role [of the Office of Laboratory Management] is acting as **the conscience** of the R&D community of the DoD, the pre-testers of new ideas and innovations about laboratories," he said.[ii] Inasmuch as conscience is an aptitude of responsiveness involving rigorous self-assessment and the deliberate sharing of knowledge (*scientia*) with oneself (*con*), the reports evaluated here offer a resounding call for the Department of Defense to improve the quality of its conscience.

Conclusion

This report provides summaries of 76 prior assessments of the Defense Laboratory Enterprise. It is intended to illuminate features of the reports that seem germane to the research questions of the Defense Science Board Task Force on Defense Research Enterprise Assessment. In order to minimize the listing of irrelevant recommendations, some reports contain only summaries, with salient recommendations mentioned therein. Some historical reports are valuable due primarily to their foundational status in constructing the present form of the defense laboratory enterprise and the structures established for its assessment. If some reports, as a result, have limited value vis-à-vis the practical concerns of the DSB Task Force on Defense Research Enterprise Assessment, they may be valuable to readers that may come later.

Prominent Trends in Historical Recommendations

1) How well do the defense laboratories respond to the needs of the Department?

The claim that DoD organizations lack the management infrastructure to adequately determine how well in-house laboratories respond to Department needs goes back at least 20 years to the DSB 1994 Task Force on Defense Laboratory Management, which claimed that the Deputy Director of Research & Engineering lacked the "information base and control systems" necessary to make such an assessment.[iii] Despite significant (DoD-funded) advances in database management, analytics, artificial intelligence, and cognitive science over the past two decades, the 2012 Report of the Defense Science Board Task Force on Basic Research indicates that the problem persists:

> *A significant handicap of conducting the study was the difficulty of getting data on the DOD basic research program. What should have been easily retrievable data required huge time-consuming, labor-intensive efforts to collect and assemble due to the lack of a modern management information system that would enable answering questions posed by DOD leadership. It is difficult to have management without management information. (X)*

Such knowledge management issues at the Headquarters level would seem necessarily to place limits on the Defense Science Board's capacity to reliably assess the quality of the defense laboratories' responsiveness to DoD needs. However, there is a difference between lacking the ability to report on laboratory responsiveness and an actual lack of laboratory responsiveness.

Aside from historical insights already mentioned, two key trends emerge from the reports evaluated: 1) variation among expert opinions produces contradictory recommendations; 2) excessive cost-consciousness produces recommendations, often demonstrably lacking supporting evidence, that add layers of bureaucracy while jeopardizing inherently governmental functions.

Variation in Expert Opinion

One unmistakable trend in the reviewed reports is that considerable variation exists among expert opinions concerning which features of laboratory management and bureaucracy are functional and which are dysfunctional. While it is safe to assume there is "a reason for every rule," in fact there are profusions of mutually exclusive reasons in different official reports, and not all experts agree on which reasons ought to determine policy. "Red Tape" is usefully defined in terms of dysfunctional rule sets[iv]; but these rules are typically a product of reasonable and functional bureaucratic innovations (taking many years of coalition building to implement) designed to ensure defense laboratories' responsiveness to DoD needs in circumstances of profound uncertainty. For example, consider the perennial debate concerning the optimal ratio of contractor personnel to in-house laboratory S&Es and staff. While suggesting bureaucratic monitoring of the effects of increasing the ratio, DSB's 1976 Task Force on Technology Base Strategy considers increasing the ratio a "healthy trend for now" that "bodes well for industry and university-based defense research." However, JL Little et al.'s 1976 DDR&E report, published the same year, considers increasing the ratio a dysfunctional policy innovation that drives in-house laboratories away from their inherently governmental responsibilities of systems engineering support and contractor oversight. By what means is it possible to determine who is "correct"?

Efforts to prevent recommended rule sets from negatively impacting DoD's "smart buyer" function are core features of evaluated reports dealing with post-Vietnam Reductions in Force (RIF), 1990s-2000s Base Realignment and Closure (BRAC), and 1970s-present efficiency-driven personnel reductions and outsourcing initiatives. However, anticipating the actual effects of personnel reduction is a contentious process, with competent experts on all sides making contradictory recommendations. The 1994 DSB Task Force on Defense Laboratory Management that recommended "at least 20%" of in-house laboratory Civil Service personnel could be eliminated and outsourced without jeopardizing DoD's smart buyer assessment capability was countered by reports claiming that these recommendations substituted economic ideology for evidence-based assessment.[v] The same 1994 DSB Task Force, acknowledging the uncertainty of its own recommendation, recommended monitoring and revising those personnel reduction decisions through a three-tiered performance review system for each laboratory whose outputs would feed into a "Laboratory Quality Improvement Program." LQIP evolved in the 1990s into a cross-agency bureaucracy for laboratory assessment and reform (today's Laboratory Quality Enhancement Panel).

Excessive Cost-consciousness

Many of the reports reviewed here suggest that the LQIP episode is emblematic of another dominant trend, namely, that excessive cost consciousness leads to recommendations that not only add layers of bureaucracy but jeopardize "inherently governmental" functions. Consider the DSB's BRAC-era reports recommending post-Cold War in-house laboratory cost savings and workforce reductions, such as DSB 1994 and DSB 2000.[vi] (The latter report recommends increasing to 50% the portion of Service R&D management and laboratory staff provided by the private sector.) Due to seniority rules, BRAC-era workforce reductions decreased the number of young in-house scientists and engineers on hand. Efforts to monitor age distributions and retirement rates among in-house laboratory personnel (using notoriously deficient management information systems) became an important component of maintaining the systems engineering expertise needed for a functional smart buyer role. However, over the course of the next 15 years many senior S&Es retired without in-house replacement. Several subsequent reports[vii] argue that, due in part to over-reliance on reducing costs rather than guaranteeing reliability, DoD laboratories' responsiveness to the Department's smart buyer needs were severely diminished, despite the existence of many layers of bureaucracy and Congressional mandates to monitor and improve manpower decisions and maintain smart buyer functionality.

As these debates over contractor to in-house laboratory personnel continue, it is important to point to historical conjunctures that offered an alternative path. For example, DSB 1981's recommendation for DoD to create a "Defense S&T Service" with executive S&E job series, if implemented, may have altered the post-Cold War conversation by providing mechanisms for protecting senior S&Es with smart buyer expertise from workforce reduction legislation and volatility, while aligning pay-scales to competitive markets.[viii] In this situation, an alternative to seniority-based workforce reductions may have incentivized preservation of the most talented young S&Es, while offering these young S&Es a career development pathway that would enhance long-term smart buyer capability. DSB 1981 describes the situation as follows, after acknowledging that "Innovation is a political process":

Over the last decade, there have been literally dozens of reports…dedicated…to the problem of the technology base. Generally speaking, the recommendations made in a majority of these efforts have largely been ignored by DoD institutionally. Part of this may be the result of the 'blue sky' nature of some of the recommendations. But a more serious problem exists when the institution fails to recognize and implement recommendations which are on target. (I-5)

2) What mechanisms exist to refurbish and recapitalize Department of Defense labs, and how do these mechanisms compare with other Government, academic, international, and industrial counterparts?

The best available summary of existing refurbishment and recapitalization mechanisms at DoD labs, including comparison with other Government and academic labs, is the 2013 Institute for Defense Analyses report *A Study of Facilities and Infrastructure Planning, Prioritization, and Assessment at Federal Security Laboratories (Revised)*. This report recommends DoD publish a comprehensive Guidebook of alternative financing mechanisms that are currently available to refurbish and recapitalize DoD labs, including instructional knowledge about the approval and implementation process. As with many other areas of R&D management, the capacity to respond to facilities and infrastructure (F&I) needs depends upon the quality of F&I management information. IDA 2013 conducted extensive personnel interviews and surveys of defense laboratories and concluded that F&I data and metrics are not standardized across laboratories and agencies. (74) It is difficult to optimize if you do not standardize (e.g. benchmarking against industry best practices). Neither do laboratories adequately connect the maintenance of F&I quality to the successful performance of laboratory missions (partly a technical issue, partly a strategic communications issue).

Interestingly, prominent historical recommendations dealing with refurbishment and recapitalization from the early 1970s and 1980s are nearly identical to those currently offered in 2016: Facilities Modernization Programs; Equipment Modernization Programs; creating an R&D specific MILCON authority; maximizing or expanding Section 219 ceilings (common in reports published after NDAA 2009); Base Realignment and Closure; amending portions of the U.S. Code to reimburse Working Capital Fund-managed laboratories for Service use of R&D facilities; etc. Here is a historical list:

- DSB 1981 recommends each Service receive "about $70M each year for the next ten years" for a Facilities Modernization Program – a sum equivalent to $200 Million per year per Service in 2015 dollars, for a total sum of approximately $6 Billion over ten years. An additional $25-30M for an Equipment Modernization Plan is recommended – equivalent to $70-90 Million per Service per year, for a total sum of approximately $700-900 Million over ten years. The report adds (in caps): "*OSD SELL THIS POLICY TO THE CONGRESS AND DoD AGGRESSIVELY MONITOR ITS IMPLEMENTATION.*"
- Numerous reports argue for creating an R&D specific MILCON authority as a means to overcome the intractable difficulty of competing for installation management funds with hospitals, enlisted housing, runways, and roads.[ix]
- Numerous reports (post-2009) argue for maximizing or expanding Section 219 ceilings for recapitalization and refurbishment.

- Numerous reports demonstrate that Base Realignment and Closure provides a pathway for recapitalization.
- Numerous reports (e.g. IDA 2013, DSB 2015) offer "increased capital leasing," e.g. Enhanced-Use Leases as a recapitalization and refurbishment pathway, along with long-term public-private collaboration on infrastructure such as hosted platforms for digital communications.
    - States, universities, or other government agencies (e.g. General Services Administration for labs not located on government property) can be partners.
- ODDR&E 1971 recommends that OSD sponsor legislation to amend 10 USC 2208(c) to provide for reimbursement of working-capital funds for use of unique R&D facilities, which would allow funds for their modification, conversion and replacement to accrue.
    - Army Working Capital Funds are already required to put 6% of revenues into a Capital Investment Program, which can be used for recap / refurb.[x]
- 1994 DSB Task Force on Defense Laboratory Management recommends closing laboratories that cannot afford to maintain a facility in the condition required for top quality RDT&E.[xi]
- IDA 2013 also recommends:
    - Institutionally co-locating F&I planning among laboratories with similar needs;
    - Revising OMB Circular A-11 economic criteria for operating leases
    - Revising F&I prioritization weighting metrics and indexes for evaluating facility and equipment quality at installations, e.g. Facility Condition Index;
    - Issuing an Executive Order encouraging alternative funding
    - Establishing an OSTP Interagency Subcommittee on F&I to:
        - Designate / compile best practices
        - Standardize F&I data and metrics across government laboratories
        - Establish external review / benchmarking organization
        - Explore alternative financing mechanisms for projects over $4 million

World class RDT&E entails regularly updating already state-of-the-art equipment and facilities. These facilities and equipment will become obsolete decades prior to the point at which existing F&I prioritization weighting metrics and technical criteria such as the Facility Condition Index and other metrics justify upgrades. These are persistent problems.

3) How well does the Department attract, recruit, retain, and train its workforce to remain technically current and flexible to respond to emerging national requirements?

Many historical reports from the 1960s develop a vision of optimizing the "laboratory environment" as an organizing principle for laboratory management and workforce development. The best reports rely on case studies and interviews rather than aggregate statistics such as research outputs and industry trends. Several studies utilize extensive interviews with laboratory scientists and laboratory directors about the qualitative and technical features of laboratory life that make defense laboratory labor more attractive than industry or non-profit research.

DSB 1962 (The Furnas Report) subsumes the following recruitment and workforce development considerations under a broader effort to design a "Proper R&D Laboratory Environment": competitive

salaries, flexible personnel policies, freedom to publish in academic forums and attend conferences, reliable financing for exploratory research, challenging and creative research topics, freedom to select and reject projects, close collegial ties to strong universities, special recognition of laboratories that outperform industry, offering workers opportunities to acts as "Honest Brokers" and participate in important management decisions, and minimization of routine work and repetitive testing. The most instructive report on the qualitative, social and behavioral components of an attractive workplace comes from the 1965 Arthur D. Little Inc. report, *Management Factors Affecting Research and Exploratory Development*. This report uses a case study methodology of eighty-seven 6.1-6.3 projects, along with personnel interviews and insights from management science and organizational theory to determine which quantitative and qualitative features of the "laboratory environment" correlate with high-quality research outcomes. The study begins by attempting to isolate quantitative features of high-quality laboratories, such as educational background of researchers and lab directors, laboratory ownership model (GOGO, GOCO, etc.), patterns of funding, etc..

> *However, as this list was gradually extended, it became obvious that any description based only on such factors would be incomplete and would fail to show significant relations implicit in our data. We therefore found it desirable to introduce terms and concepts from the behavioral sciences, and to deal explicitly with motives, attitudes, and the processes of human interaction.*

The study goes on to find that what attracts and retains top talent among laboratory directors and laboratory scientists is a "culture of discovery" providing the qualitative benefits of an "adaptively organized," participatory management style of "consensus-collaboration," where conditions of dynamic and urgent problem-solving produce leaders and role models whose authority is earned by demonstrating "wisdom and experience rather than organizational status." (I-4) Laboratory directors and laboratory S&Es who are deprived of these laboratory environments are likely to leave the defense laboratory enterprise in search of more fulfilling work. Another lesson from this study is that laboratory environments can deteriorate quickly even when state-of-the-art facilities and equipment are on hand, merely because "authoritarian" rule sets driven by a "coercion-compromise" management style repel top talent, depriving less talented S&Es of role models and incentives for excellence.

It may be the case that these reports from the 1960s merely reflect counter-cultural attitudes common in the historical context in which they were produced, rather than presenting instructions for contemporary recruitment and workforce development. Even so, the methodology of the reports suggest that case studies and in-depth personnel interviews focused on qualitative features of the "laboratory environment" can be more useful at generating improved laboratory management than aggregate statistics comparing patent filings, publications, educational backgrounds among government, non-profit, and industry laboratories, and globalization trends. This is precisely the insight motivating the 2012 RAND study, *Improving Army Basic Research: Report of an Expert Panel on the Future of Army Laboratories*. The report argues quantitative analyses of broad trends in the globalization of U.S. and international R&D workforces and research outputs "are not useful for examining the current state and likely future of Army basic and applied research." (17) One reason for this statement is that "much of what determines the quality of basic and applied research within the Army is a function of the research environment within the labs and the resources with which they are endowed." (17) These reports, in sum, suggest that high-quality, case study-driven social science research focused on improving the

qualitative experience of laboratory personnel and administrators should remain a centerpiece of defense research enterprise assessment.[xii]

4) Does the appropriate balance exist in each service between service control and laboratory director discretion so as to maximize mission effectiveness?

Determining the appropriate balance between service control and laboratory director discretion is the most frequently discussed topic in the historical reports here evaluated. Beginning in the 1960s, this discussion is most often taken up through two areas: 1) discretionary budgets for lab directors, and 2) replacing manpower ceilings with fiscal controls.

Discretionary Funds

Of the 52 successful applied research case studies examined in the 1965 Arthur D. Little Inc. report:

> *Most Events (41/52) were supported initially from discretionary funds, funds already allocated for broadly defined related work, or funds diverted from related activities; a much smaller proportion (1/52), had funds specifically set aside for the Event activity or specifically approved after the idea for the Event was brought forth….The decision to initiate work was made locally in most Events (41/52). In only a few (4/52) was the Event conceived by its sponsors and transmitted in a formal document such as an RFP; in most Events (46/52) the understanding of the need was passed on informally rather than by a formal document….Most of the Exploratory Development Events (31/52) were-carried out by teams of people, none of whom had distinguished professional reputations at the time.*[xiii]

These case studies suggest that balancing service control and laboratory director discretion is often best achieved through a combination of discretionary funds, funds for broadly defined work, and coordination of the diversion of funds from related activities when promising research ideas arise. A 1975 DDR&E report noting these trends suggested maximizing flexible block funding for basic and applied research at DoD laboratories, with 6.3 funds being task funded with budgeting, programming, and oversight controlled by the Services' Technology Base managers.[xiv]

SECDEF McNamara's Memorandum from 14 October 1961 states that "a fraction of the annual laboratory budget shall be set aside for work judged by the laboratory director to be of promise or importance without need of prior approval or review at higher levels." Determining the appropriate fraction of the laboratory budget to set aside for this purpose, unfortunately, is not a science. Current policy for the In-House Laboratory Independent Research (ILIR) program sets a recommended target ceiling of 2.5% of 6.1 funds. Previous drafts of the ILIR policy document, DoD Instruction 3201.04, set the target ceiling at 5%. The Department of Energy has had discretionary ceilings of 6% or more for basic research in recent memory.[xv] In practice, only those defense laboratories lacking a basic research-oriented mission tend to request ILIR funds.[xvi] Since 2013, federal R&D budgets have not funded ILIR to this diminished 2.5% ceiling. In the President's FY 2017 budget, ILIR spending is set at $31 million, DoD-wide.[xvii] This amounts to 1.48% of total 6.1 funding ($2.1B), leaving $21.5 million available but unrequested.[xviii] One wonders whether laboratory directors DoD-wide would choose to use the remaining $21.5 million if given the choice. In fact, no social science research has been done to determine whether increasing ILIR ceilings to different levels might affect research outcomes. How

would laboratory directors use discretionary funds if, for example, 5% of 6.1 funds, or 7.5%, were allocated to discretionary accounts? Answering these questions would require in-depth interviews and sensitivity analysis, but cannot proceed without accurate baseline data that links current basic research programming and execution with quantitative and qualitative research outcomes (e.g. effects on laboratory environment and 'culture of discovery' rather than publications or patents). Annual reports on the health of the ILIR program since the 1960s indicate that the program was originally designed to encourage a culture of discovery and promote competition among top-quality researchers for opportunities to do creative work that centralized management may not realize is valuable. DoD does not appear to be utilizing this program to its full potential.

Manpower Ceilings vs. Fiscal Controls:

"Manpower ceilings" refers to specific instructions about the maximum quantity of laboratory staff and personnel, including pay grades, contractor ratio, and billets. "Fiscal controls" includes Headquarters and Service-level payroll expenditure ceilings. The 1962 Astin Report is the first instance among the reports reviewed to recommend decentralizing personnel decisions to laboratory directors, based on a rationale that 1) the tempo of centralized personnel decision making is too slow, which weakens S&E recruitment, and 2) highly competent laboratory directors are more likely to know which S&Es need to be hired at which salary range given a particular set of skills:

> *Directors of R&D installations should be given direct control over administrative service activities required for effective support of the technical mission assigned to the laboratory, including the delegation of authority to select and appoint top-level officials in the research installation. (Vol. II:5)*[xix]

The first milestone report explicitly dealing with the policy tension between manpower ceilings and fiscal controls is a 1969 report from the Office of the Director of Defense for Research and Engineering titled *Allocating Work, Funds, and Manpower to Department of Defense Laboratories*. This report begins with a statement about DoD's lack of management information related to the impact that manpower ceilings and fiscal controls have on workload, adaptability to emerging requirements, and research quality. It goes on to recommend a 2-3 year demonstration project to exempt a small, selected group of laboratories from manpower ceilings while implementing fiscal controls (i.e. Headquarters-imposed laboratory budget ceilings.) Baseline data would be collected for each demonstration laboratory and periodic assessments made as the project proceeds. Results would be measured in terms of improved (or diminished) laboratory problem solving, shifting patterns of work and functional organization at lab-level, improved (or diminished) skill and discipline among personnel, overall size of laboratory staff, changes in the ratio of contractor to in-house laboratory S&Es, improvements in qualitative aspects of the laboratory environment, and quality of research outputs.

DDR&E's 1969 recommendation triggered Project REFLEX, a major signal of DoD's willingness to experiment scientifically with management concepts.[xx] Five of the evaluated studies, beginning in 1969 and ending in 1979, report the desirability and urgency of balancing (Headquarters or) service control with laboratory director discretion by combining centralized programming of fiscal ceilings with laboratory discretion over manpower levels, contractor to in-house personnel ratios, and allocation of work load.[xxi] The 1979 DDR&E *Removal of Institutional Barriers on DoD Laboratories* report used the

term “Integrated Control” as an “operating concept” for integrating total payroll expenditure ceilings for civilian employees customized for each laboratory, with lab directors making cost-conscious decisions about how best to achieve technical mission objectives through workforce planning, billets, contracting, etc. within those ceilings. This report envisions PPBE activities proceeding as usual, with a payroll ceiling itemized for each laboratory replacing (allegedly) oversimplified programming tools currently in use.

Knowledge Management: Perennial Capability Gap

A key historical insight emerging from evaluated reports is that defense laboratories’ responsiveness to Department needs depends upon the capacity of in-house S&Es, lab directors, and DoD leaders to absorb and utilize an exponentially growing body of scientific knowledge production and technological innovation. While personnel exchanges, industry partnerships, facilities and equipment upgrades, and balanced university-industry-service interactions are key components of this process, the most enduring historical recommendation for dealing with this problem involves electronic knowledge management as an R&D priority. Vannevar Bush was first to officially assess electronic knowledge management as a fundamental R&D task in a prescient 1945 essay, *As We May Think,* arguing as follows:

> *Mendel’s concept of the laws of genetics was lost to the world for a generation because his publication did not reach the few who were capable of grasping and extending it; and this sort of catastrophe is undoubtedly being repeated all about us, as truly significant attainments become lost in the mass of the inconsequential.*

In DSB’s 1958 *Report on Limited War*, the first obstacle to providing strategic R&D recommendations was the timely extraction of meaning from a voluminous array of relevant scientific knowledge and technical know-how. The report states:

> *There is an apparent lack of machinery at top levels for digesting and extracting basic meaning from the considerable number of quite significant component studies actually being generated….As a consequence there appears to be no adequate means at high levels for consummating the decision-makinq process with the full advantage of the required and often actually available component analyses properly digested. (12)*

Since 1958, the quantity of relevant knowledge to digest has increased exponentially. Excluding strategic and technical reports from industry, academia, and foreign sources, DoD J-Books currently list seven types of DoD-funded study and analysis relevant to R&D and acquisition management decisions[xxii]:

- “S&T Communities of Interest” studies use 6.2 funds for technology roadmapping, linking technology planning to strategic objectives;
- “Science and Technology Analytic Assessments” use 6.3 funds to conduct technical assessments of new technologies;
- “Advanced Innovative Analysis and Concepts” studies, also funded with 6.3 funds, assist the Strategic Capabilities Office’s implementation of the Third Offset Strategy, using old weapons platforms in new ways, rapidly prototyping new capabilities, conducting Red Team analyses, etc.;
- Wargames & Strategic Support Studies use 6.4 funds to help Cost Assessment & Program Evaluation personnel determine strategic plans and influence requirements generation;

- "Technical Studies Support and Analysis" uses 6.6 funds to analyze big-picture strategic topics, operational scenarios, industrial base capability assessments, R&D and acquisition policies, personnel policies, etc.
- "Policy R&D Programs" use 6.7 funds to implement Defense Planning Scenarios, Long Term Competitions, and studies of Future Security Challenges, examining political, cultural and conflict / combat dynamics, security challenges, and technology trends in great detail;
- In addition, studies covering similar ground are regularly conducted by UARCs (e.g. Johns Hopkins Applied Physics Laboratory) and FFRDCs (e.g. RAND, MITRE).

In addition to the DoD-funded studies and analyses listed above, DoD's R&D and acquisition decision-makers also seek awareness of global knowledge system dynamics, as well as think-tank studies and international studies of foreign military capabilities. To date, efforts to design DoD-specific electronic knowledge management systems capable of supporting the full intellectual agenda of extracting basic meaning from the expanding archive of relevant knowledge and know-how for purposes of R&D and acquisition planning have stalled in the concept formation stage and lost senior leaders' attention.[xxiii]

Since Vannevar Bush's earliest reports from 1945, knowledge management has been a significant source of risk in determining DoD's needs and responding to those needs through efforts of the Defense Laboratory Enterprise. Mismatches between knowledge management techniques and the tempo and urgency of DoD decision making produce a perennial capability gap.

Summaries: Defense Science Board Studies

Defense Science Board, *Report on Limited War, Volumes I-III* (1958).

Summary

This report demonstrates that the Defense Science Board has a history of boldly calling for major changes in R&D resource allocation in response to the rapidly shifting dynamics of human conflict. As one of the earliest DSB reports, this prescient and puzzling document exhibits DSB's early vision of the role it would play in the DoD R&D system. DSB members perceived the inadequacy of existing nuclear weapons to respond to "limited war" contexts, e.g. responses to insurgency and guerilla movements or proxy conflicts between Great Powers. In 1958 numerous geopolitical events suggested the need for "limited war" R&D: the Hashemite Kingdom of Iraq was overthrown and replaced with the Qassim government; Egypt and Syria unified into a United Arab Republic gesturing toward pursuit of territory; U.S. policymakers sought to prevent Soviet influence over Iranian military affairs; contingency plans were being drawn for U.S. protection of Kuwait and the Persian Gulf Region in the event of hostilities; the former French colony of Guinea declared independence and signaled non-alignment with U.S. interests; and U.S. covert operations continued in Southeast Asia. The report's general emphasis is on non-nuclear R&D; however, several recommendations are fixated (perhaps pathologically) on "the development of **extremely clean thermonuclear weapons**" that would "minimize effects…against friendly forces and noncombatants." Other recommendations are exceedingly prescient vis-à-vis the contemporary era of Phase 0 operations and hybrid / asymmetrical / unconventional warfare. For example, the report chides DoD for not paying adequate attention to R&D that targets "psychological, economic, human relations and political factors…before situations deteriorate to the point requiring actual military operations."

Office of the Director of Defense Research and Engineering, *Report of the Defense Science Board on Government In-House Labs* (Furnas Report) (September 1962: ADA955443)

Summary

"The Furnas Report" is an evaluation of three landmark studies: the Task 97 Group, the Astin Panel, and the Bell Report. In most matters it represents a concurrence with the recommendations of those reports. However, it represents intense recoil from the Bell Report's call for a thorough Bureau of the Budget analysis of the "Government Institutes" concept, which would place some defense R&D under a Tennessee Valley Authority-type management model (a very specific variation on the GOGO model). The Bell Report's recommendation was itself a response to a 1958 President's Science Advisory Committee report, which lamented the diminishment of government-owned, government-operated labs and "undue reliance on outside laboratories" (p 27). The Furnas Report claims that implementing such Institutes would be "dangerous" and "irresponsible," disrupting a delicate Industry / University / Government balance. In a supreme example of the triumph of hot rhetoric over cool reason in policy analysis, the intensity of DSB's negative response seems to have succeeded in preventing the Bureau of the Budget from conducting the economic analysis recommended in the Bell Report. In subsequent decades, it is notable that (to my knowledge) DoD has yet to publish a proper financial management analysis of the costs and benefits of the Government Institute R&D concept – leaving a major gap in DoD's knowledge of alternative governance structures and organizational forms for Research Enterprise Assessment. This is particularly interesting in light of Task 97 Group leader Donald MacArthur's claim that President Kennedy and SECDEF McNamara personally read and edited the Bell Report, indicating their approval of the recommendations outlined therein.

Recommendations

Administration / Organizational Structure

- "The DSB subcommittee believes that the establishment" of 'Government Institutes' [akin to Tennessee Valley Authority] as proposed in the Bell Report "would seriously and adversely disrupt the present balance of responsibility between the four major types of R&D organization, i.e. academic, industrial, not-for-profit and in-house organizations, to the great detriment especially of the universities and colleges."
    - "…to establish such a Federal R&D Institute…could lead to direct Federal *domination* of free scientific inquiry." (5) "Work of the sort that would be done at such institutes…should more properly be done within the nation's universities and colleges…."
    - "…certain implications in the report present real dangers of weakening not-for-profit institutions and private industry to the point where they will not serve the public interest in the DOD research and development program."
    - "The DSB subcommittee feels that such a proposal could not be taken seriously in responsible quarters if all implications and ramifications were thoroughly explored."
- We should exercise "unceasing vigilance" to ensure that we do not over-implement the Bell Report's suggestion that Government contracts should include salary limitations on contracted personnel
- "The difficulties and weaknesses that pervade the in-house laboratory system, without significant exception, flow from three main causes: noncompetitive salaries and professional

benefits, ill-conceived or misapplied bureaucratic regulations, and lack of truly significant assignments coupled with lack of adequate personal recognition. For remedial action five recommendations are made:

- 1) Continue to press for congressional action to increase top salaries and professional benefits to a competitive level
- 2) Maintain the Task 97 function on a permanent basis to ferret out unnecessary controls and frustrations and make recommendations for remedial action to the Director of Defense Research and Engineering
- 3) Establish a system of national recognition for outstanding accomplishments, perhaps through the National Academy of Sciences
- 4) Establish a liberal system of sabbatical leaves for government scientists to work in universities or top industrial laboratories, both nationally and in friendly foreign nations.
- 5) Establish a reverse sabbatical leave program for competent university and industrial scientists to work in government laboratories, including scientists from friendly foreign nations.

Joint Defense Science Board/National Bureau of Standards Panel, *Report of the Panel on Research and Exploratory Development* (July 1967: ADA955439).

Summary

This report is a foundational text in the effort to increase the stature of R&D planning and scientific management in the eyes of Congressional committees and military leaders. It builds on the 1958 Report on Limited War's call for boosting social and behavioral science research as a key focus of DoD's R&D portfolio. It also recommends a strategic communications agenda to highlight the successes of 6.1 and 6.2 research in Congressional hearings. The Panel attempts to impose order upon unpredictable scientific advances by asking DDR&E to rank-order all scientific disciplines in terms of their likely future contributions to operational capabilities – a task that future reports will continually call into question. This McNamara-era report's 17 recommendations represent a sustained attempt to integrate systems analysis and management science principles into on-going institutional experiments. Ironically, the report recommends building contingency plans for 6.1 and 6.2 budgets in the event that the Vietnam War is brought to a swift conclusion.

Recommendations

Administration / Organizational Structure

- Expand ODDR&E staff managing, interpreting, coordinating, and planning for 6.1 and 6.2
    - A distinguished behavioral scientist should be added to this staff.
- Trend from discipline orientation toward system orientation in structuring of ODDR&E should be reversed.
- ODDR&E should dialogue with services and S&E community to *rank in order* the promising disciplines and fields for DoD support and eventual exploitation.
- OXR program managers should be:
    - given as much flexibility in program choice as in-house laboratory directors
    - provided resources for topical conferences to assess health and direction of Defense fields.
    - provided additional funds in light of cuts to 6.2 budgets over previous 5 years (1962-1967)
- At least one core program in each of the OXRs should be in the behavioral science area, either in a single discipline or in an interdisciplinary association.
- ODDR&E and services should collaborate on contingency plan for renewed 6.1 and 6.2 programming in the event that the Vietnam War is concluded or other events bring a sudden return of lost funding.

Budget

- Quantitative rationale needed for 6.1 and 6.2 funding levels, based on comparison with industry

Contracting

- Federal Contract Research Centers [FFRDCs] should have a DDR&E Planning Committee composed of their chief executive officers to work out plans for improving their programs, management, quality, and effectiveness.

Congressional Relations

- Put renewed spirit into the presentation of science; develop the sense of long-term payoffs for 6.1 and 6.2 research; feature scientific and engineering discoveries in service presentations; provide speech material to senior leaders; develop informal contacts at all levels using distinguished scientists and engineers; and encourage the supported community to make its successes known and needs felt
- 6.1 and 6.2 portions of DoD budget require and deserve much more space and time in presentations to Congress, in discussions with the services, and in discussions with and visits to contractors. These interactions are intrinsically more difficult than interactions in 6.3 and 6.4.
- DoD should forcefully explain to the Congress its own view of university research and the effect of this research on graduate and undergraduate teaching. DoD has enormously strengthened American education and it should not be bashful. The ignorance outside the Pentagon of this process, of the trends toward more advanced education, and of the way high quality graduate study in the physical sciences and engineering is actually carried out is abysmal.

Further Studies

- ODDR&E should prepare a quantitative analysis of basic research and exploratory development expenditures in DoD and compare to industry expenditures for a period of 10 years.

University/Industry/Services Interaction

- As part of new funding initiatives for 6.1 and 6.2, each armed service should develop “core contracts” in particular disciplines that designate “local managers” in specific disciplines at different universities who work with DoD program managers, labs, and other local managers in their field. These cores should not be a substitute for individual contracts with individual principal investigators. [Basically, this is a BLOCK GRANT concept.]
- THEMIS and other university programs should be treated *together* in budgeting and neither should be especially sacred. This is partly a problem with House Appropriations Committee language, but only partly so.
- Relevance in 6.1 strategy should not be confused with immediate applicability. LONG-RANGE relevance and quality are the appropriate criteria for THEMIS and 6.1 funding.

Defense Science Board, *Task Force on Federal Contract Center Utilization* (February 1976: ADA027683).

Summary

This report seeks to supplement a post-Vietnam Reduction in Force (RIF) with evaluations of Federal Contract Research Centers. It strongly endorses DoD's historical reliance on FCRCs, but proceeds to rank order policies for purposes of effectively removing some budgetary line-item support for FCRCs.

Recommendations

Administration / Organizational Structure

- **[The following recommendations *are not* endorsed by DSB, but were demanded by the study sponsor]**
  - Best alternative to FCRCs is to begin by removing funding for Aerospace Corporation and MITRE, proceeding to line-item funding from all FCRCs. Modification of guidelines covering FCRCs should place all such entities into fierce competition with industry and in-house laboratories for contracts on a contract-by-contract basis. Those former FCRCs that survive the transition would still have a role in the Defense R&D system. Study and analysis performers should be replaced by organic performers, staffed by the Government.
  - Next best alternative is to set a phase-out date (5 years) for eliminating all FCRCs, leaving the determination of successor performers to a separate decision process beyond the scope of this report.
  - Next best alternative is a piece-meal reduction in FCRC support by identifying individual programs / contracts to eliminate. Industrial performers would pick up the contracts. Over a 3 year period, DoD could assess this process to determine its impact on mission effectiveness.
  - Next best alternative is to produce Government Corporations to match each FCRC
    - [This recommendation recalls the 1962 Bell Report, which views "Government Institutes" established on a Tennessee Valley Authority model as a potentially viable in-house R&D model. However, DSB's 1962 Furnas Report vehemently rejects this suggestion as "dangerous" and "irresponsible".]
  - Next best alternative is establishing Civil Service Agencies in all relevant areas
  - Finally, technical military personnel could be organized to perform the missions of FCRCs

- **[The following recommendations *are* endorsed by DSB]:**
  - DoD should take a "hands off" approach to Lincoln, PSU Applied Research Laboratory, and JHU Applied Physics Laboratory, since these entities are stable and highly responsive
  - Steering committee needed at DoD to assist RAND in modifying its portfolio to non-Air Force tasks
  - IDA should develop a stronger problem orientation to justify its existence through usefulness to DoD decision-making
  - MITRE and Aerospace have to understand manpower fluctuations will result from lack of guaranteed funding
  - Staff salaries at FCRCs should remain market-determined

Defense Science Board, *Task Force on Technology Base Strategy* (October 1976, ADA032372).

Summary

This report contradicts JL Allen et al.'s 1975 DDR&E assessment of the negative consequences of increasing the ratio of contractors to in-house personnel. In this report, DSB claims the increasing ratio is a "healthy trend" that benefits industry and universities, while Allen et al. consider it a dysfunctional trend that 1) reduces basic research funding for university researchers and 2) drives in-house labs away from their primary responsibility of 'system design support'.

This Task Force did not evaluate the efficiency of management structures or attempt to propose structural improvements to budget management. Most recommendations in this report are specific to programming in particular technology areas in Environmental and Life Sciences, Electronics, and Engineering Technology. Notably, this report is a rare case of vocal support for dramatic increases to social and behavioral science funding. In response to 1975's intense focus on budget cuts and RIFs, this report recommends achieving overall improvements in mission effectiveness by focusing on specific opportunities for increased funding in particular areas, opportunities for decreased funding in other areas, and areas where program integration and focus could produce cost-reductions.]

Recommendations

Budget

- Trend toward block funding for Technology Base (6.1, 6.2, and part of 6.3) should be encouraged, as it provides flexibility for cutting marginal programs and supporting new ideas as technical assessments are produced.
- Trend toward a higher ratio of contractors to in-house research bodes well for industry and university-based defense research. It is a healthy trend for now, but continued assessment is required.
- Increased investment for environmental science and behavioral science is advised. For every dollar the DoD Technology Base invests in hardware, it invests only 9 cents on environmental science and 5 cents on behavioral science. There is solid evidence that the payoff for improved man performance or improved ability to understand and operate in adverse environments greatly increases the value of existing and future weapons systems.

Education

- New training techniques, particularly simulators, can dramatically reduce costs in a broad spectrum of military training programs

Defense Science Board, *Report of the Defense Science Board Summer Study Group on Fundamental Research in Universities* (1976).

Summary

This report responds to the perceived negative consequences of the 1969 Mansfield Amendment to the Military Authorization Act, which barred DoD from using funds "to carry out any research project or study unless such project or study has a direct and apparent relationship to a specific military function." As a result of the amendment, DoD terminated Project Themis, which from 1967-71 provided $95 million in block-grants to universities that had previously not been awarded significant DoD contracts ("have-not schools"). The report exemplifies two primary roles of DDR&E: first, the role of a "Washington Representative" advocating on behalf of the DoD R&D system to Congress and the Executive branch, diagnosing dysfunction in R&D policy trends. The report focuses on a dysfunction it calls "Mansfield Syndrome," which symptomatically pushes R&D toward an extremely narrow focus on short-term military requirements at the expense of long-term fundamental knowledge production. The report's recommendations seek to "re-balance" DoD priorities vis-à-vis short and long-term S&T needs by establishing new basic research funding guidelines. Second, the report exemplifies the importance of DDR&E's Office of Laboratory Management as a pre-tester of new R&D management ideas, coordinating broad evaluation of policy options within DoD and among stakeholder agencies prior to program implementation – a role emphasized frequently by DDR&E leadership in the 1960s and 70s. Office of Laboratory Management director Donald MacArthur in 1968 Congressional testimony referred to these roles together as "the conscience of the R&D system of the Department of Defense."

Recommendations

Administration / Organizational Structure

- DoD should not demand that a scientist demonstrate that his research project or program is relevant to military needs
    - [This direct contradiction of Mansfield Amendment language suggests that DoD will be better off in the long run if it has mechanisms for funding fundamental knowledge production that are *procedurally independent of* DoD / Congressional assessments of current or future military needs.]
- Research relevance should be evaluated in relation to a field or discipline rather than an individual project or program
    - The following guidelines and principles should structure these evaluations:
        1. *Decisions regarding the division of funding among various disciplines and fields are legitimately reserved to the Service research managers and ODDR&E*
        2. *These decisions should be made by taking into consideration recommendations of advisory committees from the involved scientific community*
        3. *In addition, disciplinary funding decisions should be coordinated with programs in other government agencies supporting basic research*

4. *Once a policy for allocation of funds among scientific disciplines and fields of research has been established, proposals that are received should be judged on the basis of quality. As far as is politically possible, considerations of geographic distribution, etc. should be minimized*

- [The Reliance 21 framework with its Defense Basic Research Advisory Group and Communities of Interest partially addresses these concerns, along with broad research areas identified by each of the Services, e.g. Army Research Laboratory's six S&T Campaigns]

- Peer review mechanisms that minimize delays in administrative response, developed by and for the Service OXRs, and explained to academic scientists, should drive basic research proposal evaluation
  - A certain percentage of 6.1 funds should be exempt from complete peer review, in order to facilitate discretionary funding of promising research
    - [The ILIR program permits discretionary, laboratory-specific proposal evaluations that minimize evaluation lag-time, and was already available in 1976. ILIR is designed for in-house research, not extramural research; but ILIR funds can be awarded to university researchers gaining PhDs from extramural institutions when research is performed at UARCs / FFRDCs, or when the student enters an in-house laboratory as a visiting researcher.]
- Well-documented historical examples [i.e. case studies] should be presented to Congress, OMB, and the public to exhibit the relevance of fundamental research

Budget

- DoD could establish a specific 6.1 account for non-tenured, early-career faculty members or faculty members not previously supported by DoD funding
  - [NSF established the first Young Investigator Program / Young Faculty Program in 1984. The Office of Naval Research had an established YIP program in 1989. It is plausible that this DSB recommendation is among the earliest instances of this excellent R&D management innovation.]
- To attract and maintain world-class talent, DoD could provide 5-year "Awards for Fundamental Science" for selected scientists at a level of $200,000 to $250,000 per year [equivalent to ~$800,000 to $1 million in 2015 dollars]
- "Institutional general research grants" [i.e. block grants for fundamental research] could be awarded to specific institutions that can demonstrate quality control within established guidelines
  - [This recommendation is intended to restore the importance of DoD initiatives like Project Themis. As a result of the Mansfield Amendment, DoD in 1971 terminated Project Themis (1967-71), which established "centers of excellence" at under-represented universities to pursue: detection, surveillance, navigation and control;

energy and power; information sciences; military vehicle technology; materials sciences; environmental sciences; medical sciences; and social and behavioral sciences.

- [NOTE: From 1986 to 1991, DoD's University Research Initiative (URI) funded 80-100 block research grants covering $100 million, according to a 1991 Office of Technology Assessment report *Delivering the Goods: Public Works Technologies, Management, and Financing.* The extent to which this 1976 DSB report was responsible for pushing URI toward block-funding is indeterminate.]

Contracting

- Large departmental or multi-departmental contracts (over $1 million) could be negotiated with specific universities or university consortia for basic research in specific disciplines or fields
    - [This in fact is how many inter-agency initiatives are currently performed in 2016, e.g. programs of the National Nanotechnology Initiative coordinated by OSTP.]

Facilities & Equipment

- "Total cost approach" to S&T funding at universities:
    - DoD should develop guidelines and policies for allocating funds that will give high priority to new equipment and instrumentation, including realistic provisions for operation, maintenance, and repair
        - [NOTE: Capital equipment and facilities upgrades at DoD laboratories remain stifled by inadequate cost estimation frameworks and lack of guidelines for prioritizing purchases in installation management offices, according to a detailed 2013 study by the Institute for Defense Analyses, *A Study of Facilities and Infrastructure Planning, Prioritization, and Assessment at Federal Security Laboratories.* For example, IDA reports that existing F&I project assessments permit state-of-the-art facilities to become obsolete -- e.g. "The Facility Condition Index only tells you the basic structural capability of a building [which might be perfectly adequate], but not whether it has the right hoods or the vibration level you need to do science."]

Defense Science Board, *Report of the Defense Science Board 1981 Summer Study Panel on Technology Base* (November 1981: ADB064056).

Summary

This deeply insightful study, which includes recommendations from a Laboratory Management Task Force (Appendix H), begins with a "no illusions" perspective, noting that "Innovation is a Political Process":

> Over the last decade, there have been literally dozens of reports…dedicated…to the problem of the technology base. Generally speaking, the recommendations made in a majority of these efforts have largely been ignored by DoD institutionally. Part of this may be the result of the 'blue sky' nature of some of the recommendations. But a more serious problem exists when the institution fails to recognize and implement recommendations which are on target. (I-5)

Notably, the Laboratory Management Task Force responds to laboratory personnel workforce reductions mandated in the Defense Authorization Act of 1978. The Task Force urges SECDEF to support the repeal of Section 811(A) of that law, which would have required 2% per year reductions to GS-13 to GS-18 (SES II) personnel. The Task Force recommends a special pay group covering defense S&E job series: "in effect, a Defense Science and Technology Service." To continually refurbish and recapitalize facilities and equipment for in-house laboratories, the study recommends providing each Service with "about $70M each year for the next ten years" [$200M per year per Service in 2015 dollars] for a Facilities Modernization Program, and an additional $25-30M [$70-90M in 2015 dollars] per Service per year for an Equipment Modernization Plan. The Task Force implores: "OSD SELL THIS POLICY TO THE CONGRESS AND DoD AGGRESSIVELY MONITOR ITS IMPLEMENTATION."

In general, the study finds DoD S&T investments inadequately responsive to the requirements of future combat. Specifically, the study identifies lack of funding for DoD technology demonstration programs and university research faculty, facilities and equipment. In response to these findings, the Panel recommends that USD (R&AT) institutionalize a "scenario oriented basis" for S&T investments. The Panel additionally recommends USDRE establish an advanced projects agency for technology demonstration, staffed by personnel from the Services, to quantify the maturity of emerging technologies and conduct "test marketing" experiments.

As for budgeting, the Panel recommends "de-emphasis" of DoD's in-house basic research program, with a corresponding 25% increase to competitive university research investments and a .5% increase to the IR&D budget ceiling. To provide talented personnel, the Panel recommends each Service to provide 100 graduate fellowships per year in key areas at a cost of $20K/year per fellow, with a one year post-fellowship in-house laboratory work commitment for each year of fellowship funding.

Recommendations

Administration / Organizational Structure

- OSD should work with OPM to create a Defense S&T Service
    - S&E job series would be protected from broader workforce reduction legislation and volatility, while aligning pay-scale to competitive market
- Establish an advanced projects agency for technology demonstration, staffed by personnel from the Services, to quantify maturity of emerging technologies and conduct "test marketing" experiments using a "fenced funding" model to maximize accountability
- USDRE should direct Services to review DARPA programs over $30 Million for potential future military applications, operational needs and transition plans
- USDRE should designate lead laboratories in generic technology base areas
- ASD (R&T) direct Services to create a DoD thrust to upgrade equipment at universities

Budget

- About $70M each year for the next ten years [$200M per year per Service in 2015 dollars] for a Facilities Modernization Program
- $25-30M [$70-90M in 2015 dollars] per Service per year for an Equipment Modernization Plan
- Resource allocation for S&T investments should be placed on a "scenario oriented basis"
- Increase university 6.1 research by 25% in real growth over next three years
- Increase IR&D ceiling by .5% to permit more university-industry collaboration

DSB 1982 Report of the Defense Science Board Task Force on University Responsiveness to National Security Requirements

Summary

This report, requested by the House Armed Services Committee, seeks to provide a framework that DoD and university representatives can use to develop Export Control guidelines, which could then be designed into efficient contract vehicles for DoD-funded R&D programs. The report also calls for sustained DoD support for laboratory equipment upgrades at universities, programs to fill vacant engineering faculty slots and expand ROTC, and regulatory changes (e.g. acquisition and procurement) to make Independent R&D more attractive to industry. It additionally suggests using the Defense Science Board as a mechanism for DoD officials to periodically discuss the Department's national security needs and concerns with university representatives. Finally, it suggests that DoD team up with private industry and the National Research Council to publish a comprehensive catalogue of all available "fellowships, assistantships, scholarships, and manpower training grants offered by government, industry, foundations, and other institutions connected with the universities."

Recommendations

Administration / Organizational Structure

- Under Secretary of Defense (Research & Engineering) should create a forum to allow periodic consultations between university representatives and DoD officials on the full range of research-related needs and issues that affect the Department's ties with universities. The Defense Science Board, which already has university representation in its membership, could service as the mechanism for creating such a forum
- USDRE should give guidance and support to the Services to increase 6.1 Research funding to universities, over and above any special provisions for instrumentation, to accommodate real sustained growth
- To encourage increased Independent Research and Development (IR&D) in industry, USDRE should direct Defense Acquisition Regulations Committee to revise current procurement policies and regulations
- Within the overall increase in funding for universities, target critical needs for special attention
    - DoD should cooperate with other agencies and departments on research funding, fellowship awards, and other support to ensure stable, growing basic research and engineering programs at universities that are responsive to DoD critical needs
- USDRE should make available an unclassified version of the Military Critical Technologies List to educate the university research community about DoD's technology transfer concerns

Contracting

- DoD should support the Short Form Research Contract (SFRC) now being tested by DoD as a contract vehicle for 6.1 research at universities

- DoD should also pursue consulting agreements as a means to promote closer ties and long-term relationships between university faculty and defense projects in DoD in-house laboratories or FCRCs
- Develop standard contractor proposal formats

Education

- ASD (MRA&L) should increase funding for ROTC programs, broadening coverage and scope, if necessary, to attract outstanding students to military careers
- USDRE should authorize each Service to award additional S&E graduate fellowships and educational support annually similar to those contained in FY 1983 budget (40-50 new research fellowships at the $15,000 level) – [i.e. $36,000 in 2015 dollars]
    - Award fellowships to U.S. citizens only
- SECDEF should encourage other agencies to strengthen foreign language and area studies programs, particularly those authorized under Title VI of the Higher Education Act of 1980
    - DoD should assess the consequences for national security of weakened university research and training capabilities in these areas, and expand DoD mechanisms to support its needs

Facilities / Equipment

- USDRE should direct Services to provide funding to universities specifically aimed at improving university equipment and facilities for a sustained period, over and above 6.1 Research funding
- Consider Tri-Service funding and coordination on large capital budget items for DoD programs in connection with ongoing research contracts

Manpower / Personnel

- Utilize Intergovernmental Personnel Act authority to promote university/government personnel exchanges for periods of up to two years
- Through a joint effort in government and private sector (e.g. National Research Council), encourage the publication of a general catalogue listing fellowships, assistantships, scholarships, and manpower training grants offered by government, industry, foundations, and other institutions connected with the universities.

Defense Science Board, *Task Force on Defense Laboratory Management* (1994).

Summary

This "BRAC 95" Task Force re-affirms the importance of in-house laboratories conducting inherently-governmental 6.1-6.6 activities in response to DoD needs. However, its central claim is that is that an imbalance exists between in-house laboratory activities and activities among industry, academia, other U.S. agencies, and foreign allies. In order to establish what seems to be the appropriate balance, the Task Force recommends resizing and restructuring defense laboratories, including (1) a 20% reduction of in-house laboratory Civil Service personnel and (2) extensive outsourcing of defense laboratory activities.

This report begins with a strong critique of the office of the Director of Defense for Research and Engineering. DDR&E is portrayed as incapable of determining to what extent the in-house laboratories respond to DoD needs. DDR&E also does not have the "information base and control mechanisms" needed to properly evaluate armed services budget program proposals and requests for military construction, laboratory recapitalization, and refurbishment of equipment.

Due to this lack of access to reliable laboratory management information, the report recommends that OSD obtain such data directly from automated management information systems at each DoD laboratory and RDT&E agency, FFRDC, UARC, and DoD-supported university laboratory. Astonishingly, without having obtained and assessed the data it claims to require, the Task Force estimates that only 20% of total 6.1-6.3 funds and only 30% of 6.4-6.7 funds should be expended at in-house laboratories (80% and 70% outsourced, respectively). This estimation, even without supporting evidence, permits the Task Force to recommend that "at least 20%" of in-house laboratory Civil Service personnel can be eliminated without jeopardizing readiness, "smart buyer" assessment capability, or ability to fully respond to inherently-governmental DoD needs.

After confidently floating outsourcing estimations, the report then provides a mechanism for, in effect, mitigating any negative consequences of implementing its recommendations that might result from obtaining the management information it says is needed. DDR&E will coordinate three tiers of biennial or triennial performance reviews of each laboratory: an independent technical review by a Lab Technical Peer Review Group, a customer review conducted via DDR&E survey, and a management review produced by OSD. A Laboratory Quality Initiative Program will assess the implementation of laboratory management initiatives rooted in these performance audits.

Recommendations

Administration / Organizational Structure

- OSD shall prepare a biennial DoD Technology Plan addressing the 21 key technology areas
- DoD should review S&E qualifications and develop a plan to reduce in-house Civil Service personnel by 20%

- DDR&E should coordinate 3 layers of biennial or triennial laboratory external audits of performance
    - OSD management review to compare each lab's GPRA plans and reports with DoD's Management Information Systems
    - Third party technical review by Lab Technical Peer Review Group
    - Customer review regarding product relevance and effective laboratory outreach (surveying program managers, combatant commanders, other commanders and agencies related to labs, industrial and academic partners)
- DDR&E should re-charter Laboratory Demonstration Program as the Laboratory Quality Initiative Program

Budget

- A lab should invest 5-10% of available funds in processes, equipment, people and projects it deems most important to its mission. Since ILIR funding rarely approaches this proportion, labs must urge customers to support ILIR projects, or contract for such research. The lab's priorities for unfettered investigation should be explicit in its plans

Facilities / Equipment

- If a service or lab cannot afford to maintain a facility in the condition required for top quality RDT&E, that facility should be closed and its work assigned to another lab within DoD or outsourced
- Equipment and facilities should be added only when the capability they would provide is (1) unavailable elsewhere, (2) critical to the lab's mission, and (3) designed to meet the needs of multiple users

Further Studies

- Each military department shall provide DDR&E with a laboratory facility status review including site-by-site MILCON projects underway, planned, and completed in previous 5 years; a lab-by-lab assessment of backlog of maintenance and repair; and an assessment of the adequacy of existing facilities and major equipment

Manpower / Personnel

- Lab Directors must aim at an annual personnel turnover of at least 10% via retirement, transfer, and "culling of low performers."

University / Industry / Services Interaction

- DDR&E shall convene a continuing series of S&T meetings to expose academia and industry to DoD needs

Defense Science Board, *The Creation and Dissemination of All Forms of Information in Support of Psychological Operations (PSYOP) in Time of Military Conflict* (2000).

Summary

In response to the failure of EC-130E aircraft to disseminate TV and radio broadcasts during military operations in the Balkans, this Task Force seeks to improve DoD PSYOP capabilities in terms of their ability, ideally, to prevent conflict or limit the duration of conflict while contributing effectively to a government-wide strategic communications agenda. Rather than propose an in-house R&D program, this report's recommendations insist that DoD increase reliance on the latest commercial-off-the-shelf media dissemination techniques and technologies for PSYOP purposes.

This report and its EC-130E operational failure triggering event should be viewed as components of a broader policy trend:

In 1999, Presidential Decision Directive 68 on Interagency Coordination of Public International Information signaled a long-term commitment to institutional experimentation in U.S. strategic communication policy. PDD-68 triggered the formation of a White House Office of Global Communication and two National Security Council Policy Coordination Committees in 2002. In 2003, SECDEF approved an Information Operations roadmap that separated Public Affairs, Public Diplomacy, and PSYOP as separate administrative "lanes in the road." Subsequent DSB reports reflecting PSYOP needs in Afghanistan and Iraq, such as the 2004 DSB Task Force on Strategic Communications and 2009 DSB Task Force on Understanding Human Dynamics, incorporate recommendations to dramatically increase DoD PSYOP capability as part of a broader whole-of-government approach to public diplomacy, conflict management, and national security.

Numerous reconfigurations have since been attempted. Most recently, in March 2016 President Obama's Executive Order 13721 established a renewed configuration by establishing an interagency Global Engagement Center within the State Department. The current CEG executive director is Assistant Secretary of Defense for Special Operations / Low-Intensity Conflict Michael D. Lumpkin. This contemporary integration of State Department strategic communications and ASD (SO/LIC) appears to fulfil the intent of this DSB report's recommendations, 16 years after the fact. In sum, DSB has been working with DoD and the Executive Office of the President for at least two decades to find an effective balance on these issues.

Recommendations

Administration / Organizational Structure

- DoD should create a PSYOP policy/planning staff, under coordination authority of ASD (Special Operations and Low-Intensity Conflict)
    - This staff should ensure integration of operational and tactical PSYOP with strategic International Public Information initiatives and provided planning support as described in Presidential Decision Directive 68

- OASD (SO/LIC) and USSOCOM should increase reliance on commercial providers for high-quality products
    - Furthermore, the PSYOP force should be adequately resourced and trained to engage a stable of commercial media content providers who can deliver these quality products
- Without imposing additional budgetary burdens, ASD (C3I) should either (a) provide resources to PSYOP community to implement a robust *organic* program of open source acquisition, or (b) task the Intelligence Community to provide on-the-shelf, worldwide basic information, including media and cultural background necessary to adequately inform PSYOP products in a given country
- At an estimated cost of $10 million per year, OSD and the State Department must fund, position, exercise, and maintain suitable distribution channels and brand identities, insofar as these can be reasonably anticipated for future PSYOP requirements
    - Policies with respect to the use of new and emerging transnational media need to be developed or refined
    - Liberal reliance on recognized professionals and the generous use of highly qualified commercial entities are highly recommended
    - Buying good content on which the messages will 'ride' is a necessary and desirable expenditure

Defense Science Board, *Technology Capabilities of Non-DoD Providers of Science and Technology, Systems Engineering and Test and Evaluation* (June 2000: ADA380423).

Summary

Like many previous reports, this report demonstrates DSB's decades-long commitment to the belief that increasing the contractor to in-house laboratory personnel ratio for R&D management and laboratory staffing represents a healthy trend that, if monitored properly, can reduce costs without compromising inherently governmental functions related to independent, unbiased systems engineering support and contractor oversight.

Recommendations

Administration / Organizational Structure

- SECDEF and CJCS should initiate high-level "Packard"-style Commission to develop and integrate requirements-acquisition process
- USD (AT&L) should establish an Office of Global Technology Acquisition

Budget

- USD (AT&L) should direct Services to increase S&T funding of university defense related research by 30%

Manpower / Personnel

- SECDEF should direct Service Acquisition Executives to increase to 50% the portion of Service R&D management and laboratory staff provided by the private sector, e.g. universities, industries, non-profits

Defense Science Board, *Summary Study on Defense Science and Technology* (2001).

Summary

This BRAC-era report recommends, among other things, restructuring the DoD laboratories and rebuilding the scientific and engineering workforce based on a major review of the function and workforce in each laboratory. Aside from recommending DoD to fully implement the recommendations of DSB's 2000 Efficient Utilization of Defense Laboratories report, the goal of this report's laboratory management section is to appreciate the varied missions of each laboratory and provide customized recommendations for improved aggregate lab management. [NOTE: This report was drafted before 2001 and 2005 BRAC consolidation. In 2001 there were 84 DoD laboratories; in 2016 there are 62.]

The report also recommends making operational experimentation (accompanied by independent red teaming) "an integral element of a new S&T enterprise" – a characteristic recommendation (rooted in a DoD Directive) found throughout DSB reports in the 2000s and 2010s. Notably, operational experimentation is defined as clearly distinct from exercises, training, and demonstrations. The goal of operational experiments is to provide a venue for direct collaboration between operational warfighters and technologists. Direct collaboration allows alternative R&D pathways to interact with a broader range of possible tactical, operational, and strategic concepts.

The report could have benefitted from a stronger appreciation of the range of policy options provided by decades of previous DSB reports. For example, in response to recognition that in-house research is subject to "the restrictions of the civil service personnel system," the study assumes that university management, privatization, and laboratory closure are the only reasonable alternative management paths. Reports going back to 1962 provide a wider range of salient alternatives, and these wider alternatives (e.g. federal government corporation, government franchise, joint venture) continue to be debated in official reports to this day.

Recommendations

Further Studies

- SECDEF should direct USD (AT&L) to instruct DDR&E to:
    - Review each laboratory in detail and determine individual courses of action, to include the following:
        - Administrative personnel transfers
        - University management
        - Privatization, consolidation, or closure
    - Complete review and begin taking action within 9 months with the end goal of 2005
    - In any case, especially for those likely to remain structured as they are, implement recommendations of the most recent Defense Science Board study, *Efficient Utilization of Defense Laboratories* (October 2000)

Defense Science Board, *Phase 1 Report of the Defense Science Board Task Force on Joint Experimentation* (2003).

Summary

According to DoD's FY 2001 J-Book, "The Secretary of Defense directed operational testers to become involved earlier in the acquisition process." The J-Book adds: "As a result, DOT&E is experiencing a substantial workload increase."

This Phase I report responds to SECDEF's directive by focusing (in part) on integrating the now-defunct Joint Forces Command's exploratory development and rapid prototyping efforts with operational Test & Evaluation efforts. Because Joint Force operational exercises and simulations are continuously evolving, rapid prototyping is viewed as one component of a broader shift toward simulating real-world operational conditions as part of the pre-acquisition R&D process. The report acknowledges that implementing this broader shift would be "painful" due to a further workload increase for already-strained DOT&E personnel. Nevertheless, the idea is that pursuing this approach would allow DoD to determine how a given technology might interact with alternative tactics and operational concepts. These pre-acquisition OT&E activities are viewed as "discovery experiments," providing insight into alternative capabilities DoD could obtain from different acquisition portfolios, rather than as hypothesis tests evaluating a given technology in light of well-known requirements and operational concepts.

This report's approach continues a decades-long trend in DSB reports recommending an "exploratory design approach" to correct the weaknesses of a requirements-driven acquisition process (e.g. DSB 1989 Brilliant Pebbles Task Force). The report also complements subsequent DSB reports, such as the 2008 Task Force on Defense Industrial Structure for Transformation, which views assessment of promising R&D technologies as a critical component of alternative capability assessment and cost-conscious acquisition portfolio selection.

Finally, this report should also be viewed alongside the September 2003 DSB Task Force on The Role and Status of DoD Red Teaming Activities, in order to understand how BA 6.2-6.3 products fit into a broader experimental development framework for assessing alternative R&D paths as a means of responding more effectively to DoD's needs in 21st century international security environments.

Defense Science Board, *Task Force on The Role and Status of DoD Red Teaming Activities* (2003).

Summary

This report urges the Secretary of Defense to publish a memorandum promoting widespread use of Red Teaming at tactical, operational, and strategic levels – not as an oversight activity, but as a formative component of, for example, the process of selecting a DoD acquisition portfolio. Viewed in conjunction with the 2003 DSB Task Force on Joint Experimentation, this report puts flesh on a vision of an acquisition system driven by dynamic "alternative capability assessment" processes – a vision that can be tracked all the way back to DSB's cost-conscious recommendations in the 1958 Report on Limited War. As glimpsed in the report's description of the Air Force Red Team (10-11), DoD's in-house scientists & engineers are viewed as a key component of DoD's "smart buyer" function, independently evaluating new R&D products in conjunction with tests of tactical, operational, and strategic concepts – including assessments of probable enemy responses to the fielding of these R&D products, were they in fact acquired / procured via in-house systems development / defense industrial partners. The report's explicit recommendations are not particularly salient to Research Enterprise Assessment, except insofar as this important framing (which is not apparent in the report itself) is kept in mind. In sum, the basic insight vis-à-vis Research Enterprise Assessment is that well-resourced Red Teaming efforts (as early as BA 6.2-6.4) may strengthen the inherently-governmental role of in-house scientists & engineers as independent voices in the acquisition planning process, performing activities that improves DoD's "smart buyer" capability.

Defense Science Board, *Task Force on Strategic Communications* (2004).

Summary

This report brings some clarity to the R&D process linking social, cultural and behavioral research to Psychological Operations and public diplomacy. The Task Force calls for a Presidential Directive and organizational changes to drive targeted investment in Strategic Communications, including sustained increases in funding for programs such as the Special Operations Command's PSYOPS Advanced Technology Demonstration Program. This report offers an important view of the applicability of a small portion of military R&D to a broader spectrum of techniques for achieving national security objectives, from Phase 0 to Phase V operations.

Although enabling strategic communications for counterinsurgency, counterterrorism, and stability operations is hinted at in the 2006 Quadrennial Defense Review, these topics became a key component of QDR 2010, which references "The President's forthcoming report to Congress on U.S. government strategic communication" as a plan to coordinate inter-agency efforts.

In March 2016, President Obama's Executive Order 13721 established a Global Engagement Center within the State Department, closely aligned with DSB's strategic communication and human dynamics R&D vision. The current CEG executive director is Assistant Secretary of Defense for Special Operations / Low-Intensity Conflict Michael D. Lumpkin.

Defense Science Board, *2006 Summer Study: 21st Century Strategic Technology Vectors Vol. IV*, (April 2007: ADA467596).

Summary

This report is primarily of interest because Volume IV presents laboratory management recommendations that seem to diverge from the consensus view of the overall study membership. The consensus recommendations are presented in Volume I. It is difficult to determine whether Volume IV recommendations were widely circulated or consumed by DoD decision makers. Considering that decision makers may prefer to have access to a wider diversity of expert opinion, it may be useful to explore alternative publication techniques and data presentation methods that could enhance decision makers' access to a full range of Task Force expertise, rather than mere consensus formulations. Volume IV's central recommendations are for SECDEF to 1) create a DARPA-style Rapid Fielding Organization, with funding requests of $3 billion per year, to dramatically reduce requirements-to-capabilities acquisition times, and to 2) create a Disruptive Technology Organization to provide a transition path for DARPA-developed technologies into programs of record. The report provides draft DoD Directives to make it easy for DoD to implement its recommendations immediately.

Defense Science Board, *US/UK Task Force Report – Defense Critical Technologies*, (March 2007: ADA446196).

Summary

This report is DoD's first ever attempt at an international collaborative science board, combining the U.S. Defense Science Board with UK's Defense Science Advisory Council in a joint working group to explore technical projects. The Task Force examines five transformational technology areas: advanced command environments; persistent surveillance; power sources/management for small, distributed networked sensors; high performance computing; and defense critical electronic components. The basic insight is that commercial off-the-shelf technologies cannot meet all U.S. and U.K. defense needs in these areas, but that leveraging advances from industrial sectors in some areas will be possible. Evidence of political negotiation is present, such as a recommendation to re-evaluate U.S. Export Administration Regulations to make it easier for U.K. companies to procure dual-use technologies.

Recommendations

Administration / Organizational Structure

- Re-evaluate U.S. Export Administration Regulations
- To further horizontal knowledge integration, DoD should review the U.K. DABINETT model/ approach as potential way forward in Persistent Surveillance
- DoD should expand and continue its trusted foundry initiative
- Develop joint DoD-MoD technology in areas that may provide new capabilities for defense systems but have limited commercial use
- Develop joing U.S./U.K. program on physical design, internal functionality, and human factors related to optimizing future command/decision environments

Budget

- Fund DARPA's High Productivity Computing System programme robustly

Further Studies

- Initiate studies to understand strengths, weaknesses, and vulnerabilities of COTS-based systems to counter COTS-equipped adversaries
- Conduct longitudinal analysis of emergence of novel electronics to determine whether or not the "discovery engine" has slowed down

Defense Science Board Task Force on Defense Industrial Structure for Transformation, *Creating an Effective National Security Industrial Base for the 21st Century: An Action Plan to the Coming Crisis* (2008).

Summary

In response to a tremendous consolidation of defense contractors into "Super Primes" in the 1990s, this primarily acquisition and logistics-focused Task Force finds Industry/Government relations insufficiently responsive to DoD needs in emerging 21st century international security environments. The Task Force additionally laments that "Globalization is being resisted by individuals from CIA, NSA, Military Services, Industry, State, and Commerce who should, instead, be 'reshaping the military-technological environment in which DoD must compete'." To produce a "transformed 21st Century National Security Industrial Base," the report's action plan calls for a National Security Industrial Vision that promotes competition among a broader, international supplier base. As for DoD's R&D enterprise, the Task Force expresses a worry that Super Primes tend to be conservative R&D performers, thus jeopardizing DoD's urgent quest for disruptive capabilities. As a result, the Task Force echoes its 2007 Summer Study recommendation that DoD should establish "prospectors" whose job is to scout "disruptive architectures and technologies" in commercial and foreign markets for rapid technology transition. The report also recommends increasing funds for R&D capital equipment investment and "longer-term" 6.1-6.3 programs, and suggests using R&D funds to maintain the design teams of alternative competing suppliers (including foreign suppliers) throughout early requirements development. Finally, the report emphasizes the importance of fully implementing recommendations from a previous DSB Task Force on Globalization and Security (1999), i.e. reducing Export Control and ITAR restrictions and modifying the Berry Amendment to permit DoD to purchase of crucial items / materials from foreign sources.

Notably, the Task Force's implementation plan outlines a strategic communications agenda that combines DoD offices and Congressional liaisons, industry CEOs, and other federal agencies to achieve the legislative and budgetary changes outlined in the report.

The ideas driving this report's recommendations appear in various forms in official reports and defense legislation up to the present day, as, for example, in the SASC mark-up version of the FY17 National Defense Authorization Act:

> "The NDAA contains a series of provisions designed to improve DOD's access to non-traditional commercial and global innovation through more streamlined and commercial-like processes. These include proposals to reform and improve rapid acquisition authority and rapid prototyping and rapid fielding processes."

Recommendations

Administration / Organizational Structure

- A new R&D funding source should be established for Disruptive Capabilities Demonstrations, under the DDR&E, with Service implementations, to complement DARPA efforts
    - **6% of the RDT&E budget** should go to this program
- DoD should establish "prospectors" for commercial and foreign technologies as recommended in the 2006 DSB Summer Study on 21st Century Strategic Technology Vectors: Vol 1, February 2007

- An interoperable, Net-Centric Systems-of-Systems acquisition system should replace the current platform-centric weapons acquisition orientation
- Procedural changes to acquisition workflow
    - Experimentation on prototypes should be prioritized
        - DoD should create and fund a Rapid Fielding Organization (as described in DSB 2006, '21st Century Strategic Technology Vectors, volume IV') for fast-responses to urgent operational needs
            - [Note: DoD has indeed emphasized rapid prototyping, through Reliance 21, the Emerging Capabilities and Prototyping office, the Joint Rapid Acquisition Cell, rapid capabilities offices in the Services, and in R&D through numerous DARPA programs]
    - Cost and schedule should become Key Performance Parameters in systems analysis / development planning at the Joint Requirements Oversight Council, prior to the approval of "firm requirements"
    - Program Managers should be empowered to make cost/schedule/performance trades throughout Milestone process without going back to JROC if they can obtain approval from USD (AT&L) / Service Acquisition Executive and lead-Service Vice Chief
        - Modular Open Systems Approach should supplement spiral development for long-term weapons / systems development

Budget

- R&D for future blocks of the acquisition cycle should be alloted while earlier blocks are fielded

Defense Science Board, *Capability Surprise: 2008 Summer Study Volume 1 Main Report* (2009).

Summary

This study attempts to enhance DoD's ability to anticipate and adapt to scientific breakthroughs, rapid fielding, and operational innovations among foreign state and non-state adversaries. It recommends that SECDEF establish a new office (the Capability Assessment, Warning, and Response Office) tasked with warning DoD of potentially high-risk adversary capabilities: "The Defense Science Board is normally reluctant to recommend creating new organizations, but in this case, the Board feels that it is critical to the success of managing surprise." This study also echoes previous reports in recommending that SECDEF take specific steps to make red teaming a norm throughout the Department, from operational exercises to high-level military strategy. The goal is to apply innovations in S&T horizon scanning, technology assessment, red teaming, exercises and war-gaming, rapid fielding, strategic intelligence, and integration and management to the task of anticipating and respond to surprises, to the extent possible.

Three "known surprises" are discussed: cyber surprise, surprise in space, and nuclear surprise. The task of assessing foreign capabilities, U.S. strengths and vulnerabilities, pathways for responding to these surprises, and "net potential consequences" motivates DSB's recommendations.

Dealing with truly "surprising surprises" requires institutional efforts to integrate five elements: 1) a scanning and sifting process that narrows potential surprises to a worrisome few; 2) a "red" capability projection that applies analysis, simulation, experimentation, and/or prototyping to that worrisome few; 3) a "net assessment" process that evaluates the red capability projection process against "blue" capabilities; 4) an "options analysis" team that synthesizes the previous processes to determine alternative courses of action if blue capabilities prove inadequate; and 5) an ability to produce a "decision package" that senior leadership can act upon to mitigate threats.

Recommendations

Administration / Organizational Structure

- USD (AL&T) and Chairman, Joint Chiefs of Staff, should identify a series of measureable goals and time frames for improving the nation's abilities to deter, fight through, detect, prevent, mitigate, and use appropriate offensive measures in domains of known surprises (cyber, space, nuclear)
- The Secretary of Defense formally establish a Capability Assessment, Warning, and Response Office (CAWRO) to provide DOD senior leadership with timely assessment and warning of potentially high-risk adversary capabilities, with options for addressing them.
- The Secretary of Defense direct the use of red teaming throughout DOD:
    - All organizations develop and maintain red teaming best practice guides
    - Make red teaming the subject of continuing intellectual activity and professional military education and other relevant institutions

- Require, with the Chairman, Joint Chiefs of Staff, more aggressive use of red teams in exercises and ensure retention and application of lessons learned
- The Secretary lead by example and establish a strategic-level red team to challenge and inform national security and top level defense policies and strategies
- The Office of the Secretary of Defense, combatant commands, and military services tie red-teaming products to all elements of surprise management

- The USD (AT&L) establish a standing Rapid Capability Fielding Office (RCFO) to improve DOD capabilities for addressing priority surprise capability gaps and supporting urgent war fighter needs. The office should:
  - Report directly to the USD (AT&L)
  - Operate on colorless money
  - Consolidate most, if not all, existing OSD rapid fielding initiatives into one organization, except for Joint Improvised Explosive Device Defeat Organization (JIEDDO)
  - Form dedicated expert project teams, with predefined sunset; each individual team:
    - implements a single, time-critical, priority acquisition and/or fielding project
    - is staffed with a small number of exceptional can-do people
    - has goals focused on solving a specific challenge
    - derives support from mainstream organizations as needed
    - up front plans for and negotiates transition of all ongoing efforts to lead Service with longer term responsibility
    - Provide permanent core of enabling services

Defense Science Board, *Operations Research Applications for Intelligence, Surveillance and Reconnaissance ISR* (2009).

Summary

This report recommends creating an Operations Research Community of Interest within DoD's strategic investment planning apparatus. Because there is currently "no strong central champion for OR at the Departmental level," the Task Force recommends that the Under Secretary of Defense for Intelligence establish this CoI and oversee the application of OR to run test cases and scenarios (specifically involving biometrics investment analysis and investments for balancing intelligence cycle of requirements, tasking, collection, processing, exploitation, dissemination). The report attempts to revive OR as decision support tool in selecting and evaluating alternative acquisition portfolios: "While the IC conducts truly world class OR…there has been an astounding decay in the ability of these same agencies to conduct OR in support of planning, programming, and acquisition." The Task Force's recommendations feed into a broader trend in DSB recommendations, namely, efforts to design institutional experiments that combine (and sequence) cost-conscious, operationally and strategically attuned analytic capabilities at the R&D-Acquisition nexus. In this sense, the report can be viewed alongside other DSB report recommendations (e.g. integrating R&D with DOT&E and independent Red Teaming, establishing commercial and foreign disruptive technology prospectors to enhance future capability assessment) to generate a dynamic sense of how DSB's foundational concern with improving DoD's "smart buyer" function.

Recommendations

Administration / Organizational Structure

- USD (I) should create a professional OR community of interest and practice across DoD and the IC
- Using FedEx as an institutional model, USD (I) should establish an organic ISR OR oversight function that requires, sustains, and reviews OR standard processes and practices in DoD ISR investment decisions

Defense Science Board, *Task Force on Understanding Human Dynamics* (2009).

Summary

This Task Force report recommends that the Director, Defense Research & Engineering designate a human dynamics "portfolio manager" to identify all DoD human dynamics programs (regardless of budget activity), perform a detailed "gap analysis" of needed R&D investments, and lay out a roadmap that includes budget levels and detailed program objectives. This recommendation has yet to be implemented explicitly, although assessment of many human dynamics programs occurs through the Reliance 21 Human Systems Community of Interest. It is unclear whether the extent of this Human Systems portfolio review and health assessment addresses the full scope of DSB's concerns.

The report's intent is to institutionalize the production, evaluation, circulation, and consumption of knowledge about human dynamics (economic, religious, political, and cultural influences on personal, interpersonal, and social behavior) to improve full-spectrum military operations, including Phase 0 activities intended to decrease the likelihood of armed conflict. Due to lack of organizational coordination, evaluation metrics, or a common vocabulary to describe and improve DoD investments in human dynamics, the report defers full performance of its assigned research tasks to the human dynamics portfolio manager it hopes to produce via report recommendations.

The report also attempts to motivate the Secretary of Defense to give human dynamics a prominent place in the 2010 Quadrennial Defense Review. While QDR 2010 does not include understanding human dynamics (or any variation of that basic vocabulary found in the DSB report) as a key mission or initiative of the Department of Defense, it does claim DoD will "examine capabilities to better access and produce knowledge on complex social communication systems and on the perceptions, attitudes, and beliefs of populations and stakeholders." QDR 2010 outlines budget increases for language training centers ($33 million), regional expertise, and culture training for special operations forces ($14 million). Further analysis is needed to determine if these (and more recent) measures are sufficient to fulfill the recommendations of the DSB Task Force on Understanding Human Dynamics.

Finally, the report echoes a 2007 DSB Summer Study in recommending USD (P) coordinate with the State Department to fund a Center for Global Engagement that provides a "centralized U.S. government interagency center for human dynamics knowledge and surge capacity." The recommended organizational structure would involve the State Department drafting a charter for an "independent, non-profit, and non-partisan" Center with an independent director and board of directors capable of determining user requirements and evaluating programs. In 2016, President Obama's Executive Order 13721 established a Global Engagement Center within the State Department, closely aligned with DSB's vision in some respects. The Center, however, is run by an executive director appointed as a Special Envoy by the State Department and reporting to the Secretary of State through the Under Secretary of State for Public Diplomacy. The current CEG executive director is Assistant Secretary of Defense for Special Operations / Low-Intensity Conflict Michael D. Lumpkin.

Recommendations

Administration / Organizational Structure

- SECDEF should instruct staff to develop:
    - Interoperable databases of all human dynamics knowledge (i.e. suitable, distributed enterprise architecture, user-friendly, with standard formats, evolving ontology, update schedules, and maintenance procedures)
        - Included in this effort should be a review of current and historic human dynamics data collection and database efforts for the extent to which they meet military need at the tactical, operational, and strategic levels
    - A comprehensive human dynamics strategy for stability operations
    - Directives on education and training, human dynamics advisors, and knowledge management
    - Review and determine best course of action to establish effective oversight and coordination of human dynamic activities
    - Ensure that implications for force structure and DoD appropriations of all the recommendations of this report are considered in the upcoming QDR
- DDR&E should establish a "portfolio manager" in human dynamics covering areas such as: language; socio-cultural, dynamic network analysis; and human dynamics computational modeling and simulation to track tools, models, data, and experts.
    - Responsibilities of the portfolio manager should include the following:
        - Define and develop a roadmap based on a refined gap analysis, coordinated with users—combatant commands and services. The roadmap should include a credible S&T budget and program
        - Perform an in-depth review of ongoing S&T programs in this area (regardless of budget authority) and assess their potential based on data
        - Define and implement a more robust research effort to explore the potential of relevant S&T efforts in cross-cutting human dynamics research linking dynamic network analysis to findings and models with direct military relevance

Defense Science Board, *Report of the Defense Science Board Task Force on Basic Research* (January 2012: ADA554738).

Summary

This report is rare among official reports in repeatedly claiming that the vast majority of DoD basic research program organization and management is "fully adequate," and its cost of doing business is "consistent with comparable activities" within the federal government. However, it is difficult to understand how the report can reliably justify such sweeping statements, since the report also states: "A significant handicap for conducting the study was the difficulty of getting data on the DOD basic research program." The report's central recommendation is to exploit the informal management abilities of qualified personnel to implement a "genuine technology strategy" driven from the top by visionary leaders. The Task Force suggests that the Director for Basic Research in ASD (R&E) should perform an "ombudsman" function, identifying and eliminating unnecessary and unproductive bureaucratic business practices in the basic research enterprise through collaboration with in-house laboratory directors. The report also builds on previous recommendations concerning U.S. adaptiveness to globalization trends, calling on DoD to invest 5% of its yearly 6.1 budget on research conducted overseas.

Recommendations

Administration / Organizational Structure

- ASD(R&E) should craft a genuine technology strategy
- ASD(R&E) should articulate a two-part portfolio strategy for basic research investments
    - One part should include broad investment in essentially all areas of science that could sensibly yield knowledge and know-how important for military capabilities
    - Second part should include selected, in-depth investments to provide the potential for major advances that could lead to a competitive advantage
- ASD(R&E) should ensure the tenets of a technology strategy are implemented in the basic research enterprise
    - Tenets should not only be directed toward basic research projects or programs, rather should also affect such activities as outreach to students and to young faculty, recruitment and training of government researchers and managers, and identification of S&T advisors
- ASD(R&E) should consider whether the lessons learned from In-Q-Tel can be applied selectively in DoD, for areas of technology that are advancing rapidly, and where a rich set of small companies exist
- ASD(R&E) should initiate Defense Science Study Group-like pilot programs in the Services with a goal to expand in the network of informed and engaged scientists and engineers exposed to the national defense community and its challenges
- The Director for Basic Research in ASD(R&E) should:
    - Serve as an "**ombudsman"** [i.e. public advocate or inspector general] seeking to document, eliminate, or waive unnecessary and unproductive bureaucratic business practices

    - Have responsibility and accountability for working with the DoD laboratory directors to document any activities that are unnecessary or inappropriate in a basic research environment
    - Be responsible and accountable for additional amended DFARS language as needed to address export controls, deemed exports, or other troublesome publication clauses
- DoD Basic Research program office directors should:
    - Provide an adequate number of S&T program assistants to help execute the administrative activities associated with proposal review, grant administration, workshop organization, and other program management duties
        - Program assistants should have degrees in science, technology, engineering, or mathematics
    - Facilitate personnel rotations between program management and hands-on laboratory basic research
        - Rotations can occur one day a week, can call a researcher to government service for a few years, or can include periodic sabbatical time
        - Program managers can keep their skills sharp by performing personal scientific research up to 20 percent of their official work schedule and by publishing their personal research findings in peer-reviewed journals
    - Provide funds and time for basic research program managers to attend relevant professional society meetings, both in the U.S. and overseas; program managers should fully participate in professional society activities, including publishing review articles and serving as editorial board members of professional journals
    - Place special emphasis on gleaning useful advice from DSSG, the CSSG, NSSEFF, and PECASE alumni
        - DoD should fully utilize those advisors who have shown special enthusiasm and aptitude for addressing national security challenges for basic research

Budget

    - ASD(R&E) should increase the percentage of basic research funding that is invested internationally from 2.5 to 3 percent to 5 percent over the next two years

Manpower / Personnel

- ASD(R&E) should direct all DoD basic research funding agencies to initiate summer activities to expose their basic research performers to military operations and critical technical problems relative to their mission
    - Goal: ensure each researcher understands the ultimate challenge their research may address without unduly focusing the research or limiting its potential
- USD(AT&L) should initiate pilot programs for cadets, midshipmen, and junior officers to participate in research tours at DoD laboratories, FFRDCs, or other institutions that carry out basic research in support of national defense
    - Upon completion: evaluate potential to provide similar experiences for officers as a tour of duty
- DoD laboratory directors should:

- Fully utilize existing authorities to hire outstanding scientists and engineers on a term basis, such as the Intergovernmental Personnel Act (IPA) Mobility Program and the Highly Qualified Experts (HQE) authorities
- Work with the military Services to create additional billets at DoD laboratories for qualified military officers
  - Goal: to make S&T a valued military career path, on par with pilots or intelligence experts
- Use the funds authorized by Congress to support sabbatical for experienced laboratory basic researchers at outstanding research universities
- Greatly increase the number of DoD laboratory post-doctoral scientists and engineers at the Service laboratories
- Offer summer internships to NDSEG and other DoD support recipients and develop relationships with them in order to more effectively recruit the best upon graduation
- Expand their use of the SMART, NDSEG, and other DoD scholarship programs to identify promising recruits to include all students who receive DoD grant funding

- To adapt to globalization of the Basic Research Enterprise:
  - USD(AT&L) should establish locations where U.S. researchers can work side-by-side with leading foreign scientists, following the best practices of U.S. industry and academia
  - DoD laboratory directors should increase the locations at U.S. Service laboratories where foreign researchers can work on basic research topics during a visit, term, or sabbatical without the need for security clearance, and should increase their invitational support of foreign scientists
  - DoD basic research office directors should establish programs for DoD laboratory and U.S. university researchers to spend a visit, term, or sabbatical at a foreign laboratory to interface with leading basic researchers in areas of interest to the DoD

University / Industry / Services Interaction

- The Director of DARPA should expand the Defense Science Study Group program by doubling the number of participants
  - Select group of participants every year rather than every other year and run two overlapping programs each with about 15 people, providing opportunities to bring the two groups (academics and national security leaders) together for workshops and other relationship-building activities
  - Include an appropriate number of behavioral and social scientists, and medical researchers, insofar as those areas are among those chronically getting short shrift by DoD
- ASD(R&E) STEM Development Office should:
  - Expand summer internship programs to place promising young men and women with U.S. citizenship in defense-related S&T activities between their junior and senior years in high school, between high school and college, and for their first few summers during college

    - Double the existing doctoral fellowship programs in the National Defense Education Program and the NDSEG, track outcomes, and consider even higher investments in future years
    - Ensure that fellowship programs for doctoral students:
        - Award a stipend with an amount at least 80 percent of the median annual salary for graduating students with B.S. degrees
        - Expand locations for summer internships to include FFRDCs, UARCs, and defense contractors in addition to government R&D laboratories
        - Give the school the recipient attends an additional benefit per year of approximately $10,000
- DoD basic research program office directors should rotate active researchers from academia, industry, and FFRDCs using the IPA or HQE programs, as appropriate.
    - Goal: to use these tools to keep the average time away from the laboratory low; less than five years for program managers, if possible
    - Tours should be for nominally four years to best match up with the typical rotation of three-year grants

Defense Science Board, *Study on Technology and Innovation Enablers for Superiority in 2030* (2013).

Summary

This report, pursuing a near-to-mid-term investment strategy for 6.2 and 6.3 programs, applies a horizon scanning and forecasting method that seeks "to envision the world of 2030" through the lens of key technology enablers that are not receiving sufficient attention from other federal R&D actors. The report's goal is to assess a broader set of possible R&D pathways for achieving nine desired strategic capabilities (pp. 93-94) while also freeing DoD from an "increasingly risk averse" reliance upon "scripted demonstrations, testing, and training." Like the 2003 Phase 1 Report of the Defense Science Board Task Force on Joint Experimentation, it seeks (in part) to revive an exploratory Test & Evaluation concept that "was core to the Department's strategy in the early 1990s," in which promising R&D technologies are early-on subjected to the best available training and simulation-based experimentation as a formative component of R&D program evaluation and pre-acquisition planning. As in the 2003 report, these discovery experiments are viewed in terms of a broader capacity to analyze alternative R&D pathways in light of their implications for transforming tactical, operational, and strategic concepts and doctrine. In keeping with the 2003 Defense Science Board Task Force on The Role and Status of DoD Red Teaming Activities, the report's Recommended Implementation Plans for these technology enablers involve independent Red Team assessments immediately after conceptual designs are produced.

There are four analytic components to the report's R&D investment strategy, driving its specific R&D budget and management recommendations: 1) Coping with Parity (i.e. responding to broad adversary access to technology); 2) Achieving Superiority through Cost-imposing Strategies (i.e. "capabilities that are less expensive for the U.S. to deploy than for an adversary to counter"; 3) Achieving Superiority through Enhancing Force Effectiveness (i.e. lightening soldier load, increasing warfighter resilience and performance, and improving training and exercises); and 4) Anticipating Surprise (i.e. horizon scanning, active red teaming, exploratory experimentation, enabled by emerging data analytics).

Finally, Appendix A of the report provides "eleven strategic contexts" that embody the assumptions and constraints of the world of 2030. The quality of specific R&D budget and management recommendations will, of course, be affected by the quality of these strategic forecasts. If future studies entail evaluating the quality of this report's recommendations, these studies should therefore begin by evaluating these eleven strategic contexts. For example, there is no mention of the sudden emergence of "market-state" coalitions in these 2030 forecasts, despite the increasing anticipation of such formations in the writings of key U.S. national security planners (e.g. Phillip Bobbitt).

Recommendations

Further Studies

- "In actuality, of course, research, development, and deployment are continuous processes. This study, therefore, bears repeating at regular intervals to truly prepare for the world of 2030 and beyond."

Defense Science Board *Summary Report on Strategic Surprise* (July 2015: ADA625666).

Summary

This report represents 1) the influence of scenario planning as an organizing principle for the conduct of DSB Task Forces, and 2) the influence of scenario planning as an increasingly prevalent element of planning, programming, budgeting, and evaluation of DoD Budget Activities 1-7. This report is part of a broader trend in policy evaluation and strategic budget planning for defense and intelligence, e.g. US Coast Guard Project Evergreen, FEMA Strategic Foresight Initiative, National Intelligence Council Global Trends reports, etc. The report is organized around the logic of **avoiding future regrets** vis-à-vis neglecting to monitor adversary capabilities and maintain technological superiority. The study considers specific future scenarios such as kinetic or WMD attacks on U.S. soil through the lenses of 8 technology domains: countering nuclear proliferation; ballistic and cruise missile defense; space security; undersea warfare; cyber; communications and positioning, navigation, and timing; counterintelligence; and logistics resilience. Recommendations are categorized according to these 8 technology domains and respond to assessments of the current availability (or unavailability) of "affordable and timely ideas to prevent the undesired outcome." The study encourages DoD to ensure that Budget Activity 1-7 decisions are informed by holistic assessments of possible future enemy capabilities, a task that requires coordination among DoD, intelligence agencies, and other Executive departments.[NOTE: The U.S. Army in 2015 even brought science fiction writers into the scenario planning process to influence war-gaming and acquisition planning decisions.]

This shift in DSB study methodology toward evaluation of scenario planning exercises produces profoundly nuanced policy recommendations. For example, rather than recommending DoD rely on commercial off-the-shelf technology as much as possible, as is now expected in these reports, realistic cyberattack scenarios lead the Task Force to recommend 1) a strategic mixing of COTS technology with unique, "Government off-the-shelf technology" (thus providing a vital role for in-house laboratory R&D that would otherwise not be apparent) and 2) **deliberate "obfuscation"** of the government's information technology hardware and software system acquisition choices. These and other recommendations reflect the Task Force's attempt to align its methodology and recommendations with an emerging strategic planning style among military decision-makers. This seems like a promising shift from the often-facile recommendations of previous Task Forces, hopefully signaling a return to the earliest vision statement of the Defense Science Board (as expressed in the 1958 Report on Limited War), namely, to provide strategically-relevant, operationally-informed, cost-conscious R&D policy advice built upon two-way communications with key leaders: the Chairman of the Joint Chiefs of Staff, the Secretary of Defense, and top decision making bodies in defense and intelligence institutions.

Recommendations

Administration / Organizational Structure

- USD(AT&L) should establish a joint working group with the Military services, DARPA, and the defense laboratories to identify and propose hybrid solutions to increase resilience; an initial focus should be on offensive electronic attack strategies to ensure high-integrity communications and PNT
- ASD (R&E) should reassess and focus S&T investment for satellite communications in areas lacking commercial investment

- For strategic purposes, DoD should adequately fund the creation of Government-off-the-shelf technology, and mix this technology with commercial-off-the-shelf technology in weapons systems, as adversaries are thereby forced to write DoD-specific software exploits.
    - In addition, DoD should "obfuscate" the information technology hardware and software it buys in order to force adversaries attempting to assess DoD capabilities to query DoD systems, thereby creating opportunities to detect their activities.
        - [This recommendation would clearly have implications for how DoD manages its contracting data, procurement details, etc.]
- Offensive and Defensive Cyber operations should become a strategic capability [driving R&D investments and requirements formation]
- Deputy SECDEF should charter a working group of policy, operational, and technical experts to assess how the U.S. could evolve its strategy and doctrine for creating new non-nuclear options for deterrence.
- DoD needs the capability to evaluate the entirety of adversaries' ballistic missile and cruise weapon capability in order to evaluate strategies to counteract future threats
- USD (AT&L) and OUSD (I) should develop and enhance analytic tools and techniques to exploit and share information and understanding on foreign space-related activities.

Contracting

- More capital leases for long-term needs; increased public-private collaboration for economical solutions like hosted platforms; and improved governance of communications systems

Additional Studies Relevant to Defense Laboratory Enterprise Assessment

Vannevar Bush, *Science—The Endless Frontier,* (U.S. Office of Scientific Research and Development: July 1945).

Summary

This landmark report, prompted by a letter from President Roosevelt listing four key research questions, provides principles and organizational proposals for a robust post-WWII civilian-controlled R&D infrastructure, funded by the U.S. Government. The report synthesizes the results of the four committees convened to investigate the President's four research questions (Medical Advisory Committee, Committee on Science and the Public Welfare, Committee on Discovery and Development of Scientific Talent, Committee on Publication of Scientific Information). The 35-page Executive Summary constructs a grand vision of the rightful place of science in post-WWII society, relying on frank speech and rhetorical tools for persuading the President rather than technical arguments that fully document the committees' recommendations and research methods (which included questionnaires to members of the Association of American Universities, hundreds of laboratory personnel and research administration interviews, financial comparisons (salary, equipment, research costs) of various departments at universities / institutes of technology, industrial laboratories, and nonprofit institutes), and a great deal of BOGSATT [bunch of guys sitting around the table]. The four committees achieved consensus determinations within a few months, and the final report, delivered nine months after Roosevelt's letter, enjoyed general support among U.S. scientific elites, administration officials, and key Congressional staff.[xxiv]

According to S&T policy scholars, "There is no strong consensus in the secondary literature about the actual impact of the Bush report,"[xxv] although Bush's ability to mobilize supportive scientists and policymakers was crucial to the report's enduring legacy. Worth noting is that Bush collaborated with House and Senate officials to introduce legislation implementing the report's key recommendations on the same day the report was released to the public. However, counter-legislation was introduced days later, leading to a protracted legislative battle over the organizational structure and administration of postwar basic research. The legislative impasse prompted President Truman to request an additional report, the Steelman Report, which did little to reduce the legislative wrangling. Nearly five years after initial delivery to the President, Truman signed a bill creating the National Science Foundation and formally recognized the Bush's report as formative. Additionally, the report's Executive Summary achieved notoriety in the press, becoming a national best-seller in part due to its visionary narrative style.

According to official NSF historians and many science policy scholars, the success of the Bush report vis-à-vis shaping US science policy was rooted in Bush's strategic choice to rely on powerful rhetoric rather than the reporting of quantitative and qualitative statistics his researchers had obtained.

Notably, the Bush report's emphasis on the "pure research" ideal left a major gap for government funding of "use-inspired basic research," as exemplified by Louis Pasteur and the microbiology revolution of the 19th century. In 2016, thankfully, the Basic Research office in ASD (R&E) has promoted the Defense Enterprise Science Initiative (DESI) concept, a full 70 years after Bush's report, precisely to fill this gap. The Basic Research office even calls DESI's target "Pasteur's Quadrant".

Recommendations

Administration / Organizational Structure

- National Research Foundation:
    - A new agency should be established by the Congress, devoted to the support of scientific research and advanced scientific education alone….The agency to administer such funds should be composed of citizens selected only on the basis of their interest in and capacity to promote the work of the agency. They should be persons of broad interest in and understanding of the peculiarities of scientific research and education.
        - The agency should promote research through contracts or grants to organizations outside the Federal Government. It should not operate any laboratories of its own.
        - The Foundation should be governed by a board of trustees appointed by the President from a panel nominated by the National Academy of Sciences
- Government should extend financial support to basic medical research through a National Foundation for Medical Research
- Military preparedness requires a permanent independent, civilian-controlled organization, having close liaison with the Army and Navy, but with funds directly from Congress and with the clear power to initiate military research which will supplement and strengthen that carried on directly under the control of the Army and Navy.
- Basic scientific research is scientific capital. Moreover, we cannot any longer depend upon Europe as a major source of this scientific capital. Clearly, more and better scientific research is one essential to the achievement of our goal of full employment.
- If the colleges, universities, and research institutes are to meet the rapidly increasing demands of industry and Government for new scientific knowledge, their basic research should be strengthened by use of public funds.
- To provide coordination of the common scientific activities of these governmental agencies as to policies and budgets, a permanent Science Advisory Board should be created to advise the executive and legislative branches of Government on these matters.
- The Government should provide a reasonable number of undergraduate scholarships and graduate fellowships in order to develop scientific talent in American youth. The plans should be designed to attract into science only that proportion of youthful talent appropriate to the needs of science in relation to the other needs of the nation for high abilities.
- Support of basic research in the public and private colleges, universities, and research institutes must leave the internal control of policy, personnel, and the method and scope of the research to the institutions themselves. This is of the utmost importance.

Budget

- The usual controls of audits, reports, budgeting, and the like, should, of course, apply to the administrative and fiscal operations of the National Research Foundation, subject, however, to such adjustments in procedure as are necessary to meet the special requirements of research.

Technology Transfer

- The ownership of patents obtained through use of federal funds should remain with the inventor

- Government should receive, in addition to a royalty-free license, the power to require the licensing of others

President's Scientific Research Board, *Science and Public Policy* (Steelman Report), 1947.

Summary

This is one of the foundational documents of post-WWII science and technology policy. Its recommendations demonstrate the importance of bold, persuasive visions for agenda setting in political contexts – a strategic communications principle that remains relevant. Steelman's official job title was "Assistant to the President" – basically the first Chief of Staff in US history, responsible for the highest priority strategic communications tasks of the Truman administration, such as negotiating resolutions of labor disputes with coal miners and dockworkers. Vannevar Bush was invited to sit on the panel that produced the Steelman report, but declined due to worries that the recommendations in *Science—The Endless Frontier* would be overshadowed by Steelman's recommendations. Steelman's research group extensively used survey techniques to understand how scientists view their own work and how scientists teach other scientists.

Recommendations

- The Steelman Report's first recommendation, on page VIII, is that the Government should fund a large study of federal social science programs, making recommendations to improve collaboration between social sciences and natural sciences throughout the R&D system.
    - The report quotes Detlev Bronk to justify the study: *"I cannot think of any field of research in physical science which does not ultimately lead, and usually very promptly, to new social problems. The same is true in biology and medicine. It is important, therefore, that competent social scientists should work hand in hand with natural scientists, so that problems may be solved as they arise, and so that many of them may not arise in the first instance."*
        - Note: To this day, the cutting-edge of science policy research remains the quest to validly and systematically measure, and eventually anticipate, the impacts of R&D on social change and the achievement of public values. As US Science Advisor Marburger pointed out in 2005, "the nascent field of the social science of science policy needs to grow up, and quickly." Had Steelman's report triggered the social science research assessment it explicitly called for, there may have been a 70 year tradition of such research to draw upon today.
- "1. That, as a Nation, we increase our annual expenditures for research and development as rapidly as we can expand facilities and increase trained manpower;
- 2. That heavier emphasis be placed upon basic research and upon medical research in our national research and development budget. Expenditures for basic research should be quadrupled and those for health and medical research tripled in the next decade, while total research and development expenditures should be doubled.
- 3. That the Federal Government support basic research in the universities and nonprofit research institutions at a progressively increasing rate, reaching an annual expenditure of at least $250 million by 1957.
- 4. That a National Science Foundation be established to make grants in support of basic research, with a Director appointed by and responsible to the President. The Director should be advised by a part-time board of eminent scientists and educators, half to be drawn from outside the Federal Government and half from within it.

- 5. That a Federal program of assistance to undergraduate and graduate students in the sciences be developed as an integral part of an over-all national scholarship and fellowship program.
- 6. That a program of Federal assistance to universities and colleges be developed in the matters of laboratory facilities and scientific equipment as an integral part of a general program of aid to education.
- 7. That a Federal Committee be established, composed of the directors of the principal Federal research establishments, to assist in the coordination and development of the Government's own research and development programs.
- 8. That every effort be made to assist in the reconstruction of European laboratories as a part of our program of aid to peace-loving countries. Such aid should be given on terms which require the maximum contributions toward the restoration of conditions of free international exchange of scientific knowledge."

Implemented Recommendations:

- A National Science Board was created (a la Bush and Steelman reports) to advise the President on R&D planning, but the Korean War immediately intervened prior to the Board's full staffing and first convening. These circumstances led to the Board being excluded from advising the president on Defense research. An alternative science advisory board structure was established for defense within the Executive Office of the President (to deal with Korea initially), which became the President's Science Advisory Committee (PSAC) in 1957 in the wake of Sputnik, and became the President's Council of Advisors on Science and Technology (PCAST) within the Office of Science and Technology Policy later on.

Commission on Organization of the Executive Branch, *Subcommittee Report on Research Activities in the Department of Defense and Defense-Related Activities* (April 1955)**.**

Summary

This report recommends shifting the weapon system evaluation function (a "smart buyer" role) from DoD to contractor performance located at universities or non-profit entities. It also expresses the belief that "increased effectiveness and efficiency" are likely to occur if the R&D performed at in-house laboratories is performed by contractors from "civilian economy organizations." It also makes strong recommendations to utilize the National Research Council as a way of analyzing bureaucratic structures and recommending which activities are unnecessary amenable to elimination.

Recommendations

Administration / Organizational Structure

- It is inefficient and ineffective to separate R&D functions from standardization and reliability assessments of weapons systems. The two functions need to be managed as part of one larger cohesive process.
- ASD (R&D) should "appoint a standing committee, reporting directly to him, of outstanding basic and applied scientists. The committee should canvass periodically the needs and opportunity for studies leading to radically new weapons systems. ASD (R&D) should implement this committee's recommendations appropriately where action is indicated." ---
    - [Note: presumably Reliance 21's Defense Basic Research Activity Group (DBRAG) is a contemporary expression of this recommendation.]
- "That the weapons systems evaluation group be shifted to contract operation with a university or nonprofit organization, and that it then be expanded to a size adequate for performing the studies required by the Joint Chiefs of Staff and ASD (R&D). ASD (R&D) should be responsible for the action essential to bringing the WSEG to an adequate level of size and effectiveness."
- DoD should review all committees and consultants and discontinue those committees found to be ineffective. DoD should make maximum use of the National Research Council structure and use its staff to monitor DoD-established civilian committees.
- R&D should be performed where it is most effective, i.e. much R&D should probably be performed "in the civilian economy" rather than at military installations. "Even where operations must be done in military installations, as in much of the tests for evaluation; increased effectiveness and efficiency will frequently be realized through contract operations by civilian economy organizations."

Manpower / Personnel

- "That higher levels of compensation for civil service professional employees be established, more nearly competitive with industry, and that the number of higher level civil service positions be materially increased."

Edward Eugene Harriman, "Military Versus Private Industry Versus University Control and Administration of Military Research and Development," MIT Master's Thesis, 10 May 1957.

Summary

This is a master's thesis from an MIT Sloan Foundation Fellow who was appointed to various R&D committees post-WWII. Harriman's ambition renders the text prone to sweeping statements, such as "The military R&D program should be decentralized *as much as possible*." (166) Harriman repeatedly offers strong characterizations of the importance of robust defense in-house laboratory capabilities.

Recommendations

Administration / Organizational Structure

- Overall control and administration of military R&D should not be contracted out to private industry or universities
- DoD must maintain in-house laboratory capabilities at the forefront of relevant scientific fields, because industry and university may not always be willing or capable of properly conducting military R&D, and because some R&D functions like testing and evaluation require equipment and facilities that industry and university simply do not have an incentive to procure and maintain.

Budget

- Details about how program funds will be most effectively used cannot be predicted 18 months or more in advance, because R&D planning is inherently unpredictable due to the nature of scientific advancement. Congress and the Services should understand this and design flexibility into the R&D system.

Manpower / Personnel

- Establish an integrated program for rotating top technical and scientific personnel to different positions in R&D enterprise depending on their desire for lab work or for planning / administration
- Government labs need to pay their personnel as much as industry labs pay

President's Science Advisory Committee, *Strengthening American Science* (1958).

Summary

President Eisenhower signed this report and claimed he would implement its recommendations immediately through Executive Order. This PSAC report represents the deep belief among science and technology policymakers of the era that autonomy and productivity are strongly correlated. The goal, for example, of government-contractor relationships is to allow contractors to "give their competence and judgment the freest possible opportunity to serve the Government." The 'smart buyer' discourse which assumes a tension between contractor and DoD interests is not yet apparent. The text is not naïve about how R&D functions, however; basic research, for example, is portrayed as an ongoing process often resulting from technology development. The report operates at the highest scale of organization (establishing a Federal Council for Science and Technology) while making recommendations for distributing management authority to lab-level experts: Agencies should provide "broad policy and planning" but leave detailed program development to "those performing the work." The report also exemplifies how much basic attitudes about how R&D management should function can change over the course of decades. For example, the committee explains that *private research foundations* are the appropriate funders of R&D that is too risky for industry to pursue ("They can accept the long bets.") (27-28) This is contrary to the contemporary assumption that publically-funded research should fill this role. Finally, the report presents some gold-standard rhetorical tools that translate R&D decision making processes into the language of national politics and everyday life: "Today, the average American's contribution to basic research, in the Federal budget, is less than $2 a year. A relatively small increase in this figure, by reallocation of funds, could have a tremendous impact on the national science program."

Recommendations

Administration / Organizational Structure

- "The climate and the means should be created whereby ideas which are challenging and sound but unconventional and different can be hospitably considered and encouraged." (27)
- Study patterns prevalent in industry (e.g. whether to structure labs to have independent divisions of R&D, how many policy staff are needed for adequate planning, whether to introduce a Vice President for research, the importance of vision statements on morale and productivity, etc)
- Agencies should provide "broad policy and planning" but leave detailed program development to "those performing the work"

Budget

- Philanthropic organizations and private foundations should also support "imaginative and audacious research," locating this research at graduate schools, undergraduate programs, and at individual institutions with traditions of excellence.
- The ~6% of R&D budget going to basic research in 1958 should be increased (page 5)
- Council should prepare a capital requirements projection for the entire federal S&T enterprise, broken down by Agency

Facilities / Equipment

- “When the Federal Government provides general support for capital needs it should be given only when the need is urgent, when it is clearly in the national interests and when necessary funds are not available and cannot be stimulated from non-Federal sources.” (24)
- Government agencies should permit “full reimbursement to universities for their indirect costs,” including overhead, “and to amortize capital expenditures as an allowable cost”
    - “Those Government departments and agencies concerned should uniformly modify their grant and contract provisions” in order to accomplish this recommendation
- State governments should also fund these university equipment and research efforts

Naval Research Advisory Committee, *Basic Research in the Navy, Volume 1*, (June 1959: AD0230575).

Summary

This report goes into minute detail about the complex coupling over decades among basic research, applied research, and development that produces new military capabilities. The 'life blood' of this process is the free and effective circulation of basic research knowledge on a world-wide basis.

Recommendations

Administration / Organizational Structure

- To prepare an overall R&D program, Navy should clarify which research fields are the "prime responsibility" of the Navy (oceanography), which are "a major responsibility" (meteorology, navigational astrophysics, marine biology, biological sciences, 'the claustrophobic phase of psychology'), and which are found wherever basic research is conducted (physics, materials science, electronics, mathematics).
    - World-wide literature reviews and close evaluation of manpower needed for knowledge types, coupled with machine learning and mathematical models, will provide better projections for R&D planning
- After the program areas are identified and detailed projects listed, a critical review process must align this distribution with augmented budget requests.

Budget

- As these administrative processes are conducted, the Basic research budget should be "approximately doubled," although instead of a 'magic number' for expenditure, budgets should be based on identified needs and knowledge gaps.
    - This recommendation is justified by comparison to best practices in industry
        - "Between 1947 and 1957, 14 top corporations in chemical, petroleum, communications, pharmaceutical, and materials industries tripled their research and development expenditures and increased basic research expenditures by a factor of 4.5. In the same period the Navy doubled its R&D expenditures, but increased basic research expenditures by a factor of only 1.5." (59)

- Navy should fully utilize the "No Year" appropriation mechanism for basic research programming
    - It takes, on average, 5.1 years to assemble a basic research team, perform experiments, and publish results, with the average increasing to 6.5 years when the size of the project costs more than $30,000 per year.
- Navy should fully utilize "long term advance financing", with projects given an average of two years funding up front, and individual contracts up to five years up front.

Eugene Walton, "What is the Role of the Government Laboratory? - A Questionnaire Study in One Government Laboratory," *IRE Transactions of Engineering Management Vol. EM-7, Issue 3* (September 1960): 114-117.

Summary

This fascinating document uses social science techniques to reveal the existence of a bottom-up laboratory counter-culture in which military and civilian scientists and engineers view themselves as the truth-seeking Honest Brokers of the miliary R&D system. In effect, these personnel recommend that the government empower them to administer the R&D system, because they have no profit motive and are concerned with getting past hype and salesman tactics to produce the most efficient and effective allocation of R&D resources. The article provides a strong glimpse of the "smart buyer" function as an ethical pursuit, insofar as the Honest Broker who has expertise helps solve basic "principal-agent" problems (e.g. moral hazard). To achieve the cost effectiveness and stewardship of public funds required of the smart buyer, S&Es inside laboratories report that DoD should do more to empower laboratory personnel to critique acquisition contracts and program proposals offered by DoD contractors. Since the article is documenting a questionnaire, the format is not intended to prescribe specific recommendations but to describe current attitudes about public stewardship and the importance of in-house expertise.

Recommendations

Administration / Organizational Structure

- Government labs' role is to tell the Government "the truth about what proposed weapons are most needed, the true value of what it is offered by private industry, and whether or not it is getting its money's worth on contracted efforts."
- "Lack of profit motive" is viewed by lab personnel as the key to their objectivity, and to the effectiveness and efficiency of the military R&D system overall
- Interestingly, personnel report that the Government is responsible for funding and conducting high-risk, high-reward research (which is the standard view today). The opposite view was expressed in the 1958 President's Science Advisory Committee report, where *private foundations* were described as the best funders of high-risk, high-reward research.

Secretary of Defense Memorandum, Subj: In-House Laboratories (14 October 1961).

Summary

This foundational memorandum by Secretary of Defense Robert McNamara implements many of the recommendations produced by other reports in the previous 10 years. The agenda set forth in this document is the groundwork for decades of studies that follow. The style of writing is not one of recommendations, but of commands.

Recommendations

Administration / Organizational Structure

- A. “The in-house laboratories shall be used as a primary means of carrying out DoD programs. They shall provide scientific and technical advice in the exercise of Government responsibility for development and acquisition of new weapons.”
- B. “Clear lines of technical management and responsibility shall be established for each in-house laboratory. To this end, the policies and practices of rotation of duty for officer-scientists will be such as to permit extended tours of duty in positions for which they have demonstrated technical proficiency. In addition, procedures will be established by which the principal laboratories of each service will be brought under the more effective control of the Assistant Secretaries for Research and Development of the Military Departments.”
- C. Depending upon the mission and nature of the work of the particular laboratory, a fraction of the annual laboratory budget shall be set aside for work judged by the laboratory director to be of promise or importance without need of prior approval or review at higher levels. The results of this work shall be reviewed by the Assistant Secretaries for Research and Development of the Military Departments.”
- D. “Full and complete advantage shall be taken of the existing PL-313 provisions which set compensation rates for senior personnel.
- E. “DoD will make every effort to secure rates of compensation for its senior personnel which, commensurate with the responsibilities which they exercise and their professional talents, are consistent with levels set outside as well as inside the government service.”

Federal Council for Science and Technology, *Competition for Quality* (Astin Report) (1962).

Summary

This report presents a classic case for making in-house labs more competitive with industry. It argues that maximizing lab director discretion over laboratory administration is essential for ensuring the highest quality laboratory work environments. It also attempts to align DoD personnel policies with industry standards, e.g. annual leave, flexible work schedules, relocation costs. Much of Volume 2's focus is on public relations and Congressional relations.

Recommendations

Manpower / Personnel

- Directors of R&D installations should be given direct control over administrative service activities required for effective support of the technical mission assigned to the laboratory, including the delegation of authority to select and appoint top-level officials in the research installation
- A more liberal and realistic annual leave policy for senior personnel accepting Government employment for the first time (20 to 26 days is the industry rate for senior research scientists, but Government only provides 13 days.)
- Flexible work hours for scientists and engineers due to the nature of scientific research – formal and repetitive start and stop times are not necessarily conducive to good science
- Per diem for employee and family for reasonable period of time after transferring to new position
- Flat payment based on percentage of annual salary to cover expenses of relocation

Public Relations

- Civil Service Commission should cooperate with agencies and departments to recruit scientists and engineers and inform general public of the scope and achievements of Government science and technology. Departments and agencies should give increased support and attention to these matters as well.
- Research directors should give vigorous publicity to career opportunities based only on research performance, with no management responsibilities.
- Agencies, departments, labs urged to prepare and publicize program descriptions and mission statements in clear, current, and challenging terms.
- Government-wide policy guidelines needed to permit official travel for conference attendance including for laboratory personnel

Bureau of the Budget, *Report to the President on Government Contractors for Research and Development*, (Bell Report) (April 1962: AD0417110).

Summary

This landmark report triggered one of the most significant silent controversies in DoD laboratory management history. The controversy surrounds the Bell Report's recommendation that the Bureau of the Budget perform an economic analysis of the desirability of designing government-owned corporations for some (unidentified) in-house R&D activities. These "Government Institutes," as the report calls them, would be organized on a Tennessee Valley Authority-type model, with a board of directors, independent consultants, etc. The recommendation was designed to sustain inherently governmental functions without the drawbacks of personnel constraints, budget ceilings, and other contentious features of GOGO and GOCO laboratories. According to the Glass Report, President Kennedy personally studied and modified the draft of the Bell Report, as did SECDEF McNamara. Additionally, Donald M. MacArthur (Deputy Director for Research and Technology at ODDR&E) stated in congressional testimony on April 2, 1968 that "The Bell Report has been our most authoritative source of guidance since 1963." The controversy triggered by the Bell Report emerged when the Defense Science Board published a commentary on the Bell Report five months later, calling the Government Institutes concept "dangerous" and "irresponsible." Since this episode in 1962, the Government-Owned Corporation model has received almost no attention from senior DoD leadership. From a policy analysis perspective, where the goal is to robustly explore available policy options, it is astonishing that Government-Owned R&D Corporations (which in many ways are *not* the same as GOGOs) are not studied as potentially viable laboratory management models.

Recommendations

Administration / Organizational Structure

- Bureau of the Budget should consider establishing a new entity called a "Government Institute" for the performance of certain types of R&D – "reproducing within the Government structure some of the more positive attributes of the nonprofit corporation….pursuant to authority granted by the Congress and subject to the supervision of a Cabinet officer or agency head. It would, however, as a separate corporate entity directly managed by its own Board of Regents, enjoy a considerable degree of independence in the conduct of its internal affairs….to operate its own career merit systems…The objective would be to achieve in the administration of certain R&D programs the kind of flexibility which has been obtained by Government corporations while retaining, as was done with the Government corporation [e.g. Tennessee Valley Authority], effective public accountability and control."
- Laboratory directors should be given more authority to command resources and make administrative decisions, including a discretionary allotment of funds (results of which he is responsible for)
- A technical information exchange system needs to be established for freely circulating the knowledge produced through R&D
- Management and control over national security R&D must be firmly in the hands of full-time Government officials who are also technically competent scientists and engineers
    - Training needs to be provided to S&Es interested in management and public policy [a common recommendation]

Contracting (General)

- DoD must establish ability to conduct feasibility studies and development of specifications prior to inviting private proposals for major systems development
- Preventing conflicts of interest requires each department head to consult with Attorney General to establish formal codes of conduct
    - "…we cannot escape the necessity of relying on the sensitive conscience of officials in the Government and in private organizations to make sure that appropriate standards are continually maintained." (31)
- Replace cost-plus-fixed-fee contracting with fixed price contracting wherever feasible, or if necessary provide an "incentive-type contract" that increases fees payed in response to lower costs, superior performance, and lower delivery times.
    - Cost-plus-fixed-fee contract has disadvantage of providing no incentive for contractor to reduce costs and increase efficiency -- in fact, "in combination with strong pressures from governmental managers to accomplish work on a rapid time schedule, probably provides incentives for raising rather than for reducing costs."
- Previous performance of contractor vis-à-vis low costs, superior performance, and low delivery times must be one element of selecting contract awards
- Salaries and related benefits to contractors should be "reasonable and appropriate", where this is determined through evaluation of salaries in private sector for similar work. Contracting agencies should have the power to limit the salaries of contracted personnel when it is deemed reasonable and appropriate.
    - [DSB report five months later will *vehemently* oppose this recommendation as well.]

Contracting (University)

- Wider use of grants for university basic research rather than contracts
    - Grants should be used to support "broader programs" that free scientists and engineers administering the programs to allocate resources as they see fit within broad objectives, rather than adhering to overly strict Federal resource allocation requirements.
        - However, it is not appropriate to place major reliance on "the institutional grant", i.e. an overly generalized financial award, since the purpose of the grants is to assure that university personnel and facilities are devoted to pursuing specific courses of inquiry. (38)
- Government should pay indirect costs for university research (including overhead) in many cases, but NOT when the benefit of performing the research on campus is so great that the university is so great as to justify a request for cost-sharing. (39-40)
- Major capital asset awards for universities should be established as separate grants rather than lumped together in broad program awards, in order to insure appropriate arrangements for managing the equipment and facilities.

Contracting (Non-Profit)

- Contracts to non-profit organizations should include fees that can be used however the entity sees fit, in order that they might use those funds to design independent research that maintains their world-class talent pool

- Contracts (or charters) should stipulate that, if Government furnishes non-profit entity with equipment, facilities, and working capital to obtain R&D tools, Government is entitled to first claim on those resources if the non-profit entity is subsequently dissolved

Manpower / Personnel

- Civilian pay reform is necessary to make recruitment and retention of top administrators competitive with industry
- S&Es should be sent back to university "for about an academic year every decade" to prevent their knowledge from going out-of-date.

Effects of Bell Report – Implementation of Recommendations

- Results were provided to Civil Service Commission, which led directly to features of the Salary Reform Act of 1962 and subsequent legislation
- Lab personnel were granted better access to foreign periodicals and scientific equipment
- Labs were given responsibility for performing security reviews of their periodicals, rather than having over-classification occur from higher eschelons of administrators
- Its proposal for Government Institutes on a Tennessee Valley Authority model continues to surface decade after decade

Arthur D. Little, Inc., *Management Factors Affecting Research and Exploratory Development* (April 1965: AD0618321).

Summary

The recommendations in this report are demonstrably vague. However, the report meaningfully frames defense laboratory enterprise assessment as a process of determining the social and behavioral features of high-functioning laboratory environments. Its conceptual framework of authoritarian vs. adaptive management may be facile, but it drives home the importance of fostering a "culture of discovery" as a means of attracting and maintaining a pool of highly creative and disciplined laboratory personnel. In addition, the case study methodology driving the report holds great promise for its specificity and the awareness it brings to the customized nature of laboratory management: each laboratory is unique and requires flexible management to increase the likelihood of world-class research outputs.

Recommendations

Administration / Organizational Structure

- Administrative and budgetary distinctions between budget activities (6.1, 6.2, 6.3, 6.4, 6.5) must not discourage mutual stimulation and support among weapons program activities.
    - "Exploratory development resources" should be made available to respond to problems arising in later budget activities.
- DoD should give weight to reputation of lab director when allocation 6.2 funds (exploratory development)
- Improved communication of requirements, plans, objectives between DoD top management and DoD in-house lab directors
- DoD should further encourage flexible allocation of 6.2 funds "at the local level", i.e. with ideas generated by lab staff and the lab director.
- Adaptive institutions are essential for research and exploratory development (RXD). Free competition among ideas ensures adaptiveness.
- Organization by tasks and projects rather than by a stable organization tree should be encouraged
- "Restrictive rules…such as those arising from civil service personnel policies, should be be eased as authoritarian controls are lifted, in order to make it possible for adaptive controls to function successfully."
    - DoD "should eliminate policies which prohibit technical discussions between contracting organizations and would-be vendors, *interpretations of 'conflict of interest'* which prevent well-informed and well-motivated mend from advising DoD and participating in development planning and conception, and other restrictions of free intercourse." (19)
        - [This recommendation is a direct confrontation with previous reports from civil service personnel offices concerned with conflict of interest in contracting]

Joint Defense Science Board/National Bureau of Standards Panel, *Report of the Panel on Research and Exploratory Development*" (July 1967: ADA955439).

Summary

This report is notable for its insistence on the behavioral sciences a foundational and legitimate DoD R&D pursuit. It also represents the increasing role of Congressional relations and strategic communications as a necessary administrative activity of defense laboratory management.

Recommendations

Administration / Organizational Structure

- Expand ODDR&E staff managing, interpreting, coordinating, and planning 6.1 and 6.2
- A distinguished **behavioral scientist** should be added to this staff.
- Trend from discipline orientation toward system orientation in structuring of ODDR&E should be reversed.
- Quantitative rationale needed for 6.1 and 6.2 funding levels, based on comparison with industry
- ODDR&E should dialogue with services and S&E community to *rank in order* the promising disciplines and fields for DoD support and eventual exploitation.
- OXR program managers should be:
    - given as much flexibility in program choice as in-house laboratory directors
    - provided resources for topical conferences to assess health and direction of Defense fields.
    - provided additional funds in light of budget cuts to 6.2 budgets over previous 5 years (1962-1967)
- At least one core program in each of the OXRs should be in the behavioral science area, either in a single discipline or in an interdisciplinary association.
- ODDR&E and services should collaborate on contingency plan for renewed 6.1 and 6.2 programming in the event that the Vietnam war is concluded or other events bring a sudden return of lost funding.

Contracting

- Federal Contract Research Centers [FFRDCs] should have a DDR&E Planning Committee composed of their chief executive officers to work out plans for improving their programs, management, quality, and effectiveness.

Congressional Relations

- Put renewed spirit into the presentation of science; develop the sense of long-term payoffs for 6.1 and 6.2 research; feature scientific and engineering discoveries in service presentations; provide speech material to senior leaders; develop informal contacts at all levels using distinguished scientists and engineers; and encourage the supported community to make its successes known and needs felt

- 6.1 and 6.2 portions of DoD budget require and deserve much more space and time in presentations to Congress, in discussions with the services, and in discussions with and visits to contractors. These interactions are intrinsically more difficult than interactions in 6.3 and 6.4.
- DoD should forcefully explain to the Congress its own view of university research and the effect of this research on graduate and undergraduate teaching. DoD has enormously strengthened American education and it should not be bashful. The ignorance outside the Pentagon of this process, of the trends toward more advanced education, and of the way high quality graduate study in the physical sciences and engineering is actually carried out is abysmal.

Further Studies

- ODDR&E should prepare a quantitative analysis of basic research and exploratory development expenditures in DoD and compare to industry expenditures for a period of 10 years.

University/Industry/Services Interaction

- As part of new funding initiatives for 6.1 and 6.2, each armed service should develop "core contracts" in particular disciplines that designate "local managers" in specific disciplines at different universities who work with DoD program managers, labs, and other local managers in their field. These cores should not be a substitute for individual contracts with individual principal investigators. [Basically, this is a BLOCK GRANT concept.]
- THEMIS and other university programs should be treated *together* in budgeting and neither should be especially sacred. This is partly a problem with House Appropriations Committee language, but only partly so.
- Relevance in 6.1 strategy should not be confused with immediate applicability. LONG-RANGE relevance and quality are the appropriate criteria for THEMIS and 6.1 funding.

Donald M. MacArthur, "Effective Use of Federal Laboratories," Office of the Director of Defense Research and Engineering (April 1968: AD0668344).

Summary

This text, which is a transcript of Congressional testimony of the Deputy Director of Science and Technology for DDR&E, demonstrates the ambitions DoD had for institutional experiments related to in-house laboratory management. The leaders of these institutions believed strongly that they represented "the conscience of the R&D community of the DoD." TAB D gives concise history of evolving R&D organizational innovations at DoD:

> *The Office of Laboratory Management was formally established in September of 1965. The functions it assumed at the time of its establishment were performed prior to that time on an ad hoc or special arrangement basis. [In 1964,] a position of 'Special Assistant for Laboratories' was created in the Office of the Deputy Director, Research and Technology to assist in planning the future of the DoD laboratories and develop policies concerning their operations….The Office of Laboratory Management is the organizational arm of DDR&E with respect to in-house laboratories. Its primary purpose is to assist the DDRE in the planning and the execution of a positive program which assures that the Defense laboratories of the future play key roles in shaping, carrying out, and administering the complex RDT&E programs upon which our Defense posture depends so heavily. This office is the focal point of the DoD laboratories and has been heavily involved in most of the issues I have discussed today. It is considered the 'Washington Representative' of the in-house laboratories and it tries to represent their positions and points of view at the corporate level….**An important role is acting as the 'conscience' of the R&D community of the DoD**, the pre-testers of new ideas and innovations about laboratories.*

TAB C is a history of the legislative authorities for inter-agency / inter-departmental work – 1932 Economy Act states "any executive department…if it is determined by the head of such department…may place orders with any other such departments…for materials, supplies, equipment, work, or services of any kind that such requisitioned federal agency may be in a position to supply or equipped to render and shall promptly pay…the estimated or actual cost thereof as determined by such department…as may be requisitioned."

Recommendations

Personnel

- **Eliminating manpower ceilings** for cross-agency work would motivate greater utility of lab capabilities and achieving Congressional objectives

Office of the Director of Defense Research and Engineering, *Allocating Work, Funds, and Manpower to Department of Defense Laboratories* (1969: AD0889192).

Summary

This report presents a milestone in the policy tension between manpower ceilings and fiscal controls at DoD laboratories (a tension that overlaps with another policy tension between centralized management and lab director discretion.) The text begins with a stark statement about DoD's lack of management information related to some of the key variables of R&D laboratory management: "…[T]here is no meaningful correlation between research, development, test and evaluation (RD&E) work load, funds, and manpower within the PPB system at any level of management within the Department of Defense." As a result, it recommends implementing a carefully monitored pilot project, Project REFLEX.

Recommendations

Manpower / Personnel

- Implement Project REFLEX as proposed
    - 2-3 year demonstration project to exempt a small, selected group of laboratories from manpower ceiling
    - Institute fiscal controls (two large labs, four medium sized, and four small labs; 4 Army, 3 Navy, 3 Air Force; total of 16,000 people)
    - Demonstration operational by first quarter FY71
    - Baseline data will be collected for each demonstration laboratory; periodic assessments made as project progresses
    - Focus will be on lab problems solved, changing patterns of work and functions, changes in skill and discipline mix, overall size of staff, validity of fiscal controls, shift in type of work from contract to in-house or vice versa, improvement in lab environment and lab quality, ability to attract and retain quality people, measures of output compared to past,

Office of the Director of Defense Research and Engineering, *Joint Program of the Civil Service Commission and the Department of Defense to Resolve Problems in the Management of Defense In-House Laboratories* (June 1969: AD0694449).

Summary

This report summarizes for DoD leadership the 1967 Civil Service Commission report titled "*Problems in the Management of Department of Defense In-House Laboratories"*, which cited 21 problem areas, 33 specific problems, requiring 104 separate recommended actions, of which 34 were considered 'critical'. Unresolved problems are listed below.

Recommendations

Administration / Organizational Structure

- DoD and Departments should encourage the use of outstanding laboratory personnel on key scientific and policy committees.
- Directory of Laboratories and local lab management should make judgments about the desired balance between in-house and contract programs in each laboratory.
- Long-term goal is to decentralize administration of manpower and organization controls
    - Short-term: Increased delegation of authority for manpower, organization, and personnel management to lab directors
        - Post-audit reviews should be used to check on laboratory use of delegated authority to establish and fill GS-14 and GS-15 positions and place personnel at proper career ladder levels.
        - Rapid review systems are needed to obtain expedited review and approval of requests for "supergrade" positions [GS-16,17,18] and Public Law 313 positions to compete for top management and senior staff.
- Delegation of authority to lab directors to make exceptions to manpower ceilings, grade, and organizational control procedures
- Replace lab-level manpower ceilings with Headquarters-imposed fiscal controls, permitting lab directors to decide how best to staff laboratories within fiscal limits.
    - [This is the same recommendation that motivates Project REFLEX in 1969]
- Eliminate Table of Distribution and Allowances system for Department of the Army for RDT&E organizations, unless immediate improvements can be made to delegate authority to lab directors
    - TDA classifications especially should not be used to deny interdisciplinary scientists career paths due to deficiencies in the classification of personnel

Education

- DoD should consider expanding the pool of manpower spaces for long-term training to include cooperative education
- Army should consider requesting Civil Service Commission to approve higher local pay rates for cooperative education students

Manpower / Personnel

- Standardized manpower control procedures for RDT&E across DoD.
- Departments should be permitted to develop selective systems to use overtime to meet RDT&E needs
- In-house laboratory personnel levels should not be determined by contemporary "productivity assessments"
- Army: Technical personnel at laboratories should visit more colleges than are now centrally scheduled to recruit needed personnel
- Laboratories should use temporary assignment to non-sensitive positions for new employee while security clearance process is taking place
    - [This recommendation is similar to those in 2014 for providing university researchers with opportunities for unclassified research in DoD labs – see July 2014 IDA study, Research Collaboration…]
- DoD labs should extend probationary period for evaluating new S&Es beyond current 1 year threshold.
- DoD needs to focus on fixing its summer employment system (housing, certification exams, pay grade determination, non-competitive appointments for qualified candidates)

Office of the Director of Defense Research and Engineering, *Report of the Panel on R&D Management* (18 July 1969: ADA955448).

Summary

This report synthesizes and evaluates recommendations from previous reports, and is based on an acquisition typology of Concept Formulation, Contract Definition, and Source Selection. Note: on page 19 of the report, immediately after providing a list of recommended actions, the Panel undermines its recommendations by listing a number of "obvious pitfalls in the approach suggested by the Panel," which may make some of their own recommendations on improving Concept Formulation appear dubious.

Recommendations

Administration / Organizational Structure

- DDR&E should revise DoD Directive 3200.9 "Initiation of Engineering and Operational Systems Development" dated 1 July 1965 to emphasize the type of effort that is required in Concept Formulation [described below].
- Concept Formulation needs to involve laboratory test, and the design and evaluation of development prototypes
    - [Budget Recommendation] This does not require more RDT&E funds overall, but rather more 6.3 funds allocated to development during Concept Formulation rather than during Contract Definition.
    - [Budget Recommendation] A mechanism is needed for coordinating communication across services [for joint programs] to determine how much 6.2 and 6.3 funding is needed for Concept Formulation
- DDR&E should have approval authority for Advanced Concept Development Paper [[which frames the technical need and expectations for an acquisition program]
    - Advanced Development Concept Paper should be based upon in-depth studies and analysis of alternate means of satisfying an existing or projected operational deficiency, should be updated semi-annually or annually, addressing operational use, but not procurement and force structure issues.
- Departments' Assistant Secretary for R&D should be responsible for designating program manager, determining when to start and stop studies and analyses, and making project decisions based upon results of those studies.
- DDR&E should be able to modify Development Concept Paper as funding, schedule, or performance change, without extensive re-coordination.

Contracting

- Program manager flexibility has to be enhanced, including power to slide production decisions without invalidating future contractor commitments.
    - For production portions of combined R&D and production programs, a careful study should be made to develop contractual policy and language to provide the flexibility to slip production decision dates if technical progress on the program is not sufficient to justify such decisions.

- DoD should employ Cost Plus Incentive Fee (CPIF) contracts with carefully structured incentives where technical uncertainties are large or where the Government objectives are likely to change substantially
    - [The report wants to dissuade DoD from returning to "a cost-reimbursable frame of mind" by overreacting about misuse of Fixed-Price contracts, which were thought to incentivize inflated prices and low productivity among contractors]
- For programs of intermediate complexity (such as a tactical missile), use "try-before-buy" competitive development of breadboard or development prototypes to maintain competition before production contract award.
- DoD should eliminate or curtail the implementation of the following costly contract oversight mechanisms that add significant overhead costs and do not deliver sufficient savings:
    - Cost Reduction systems do not actually reduce costs (as the title implies) but rather report cost savings achieved by other technical and management controls that would continue to produce those savings in the absence of such reporting systems.
    - Value Engineering programs have been misused by showing savings on changes that should have been foreseen to begin with
    - Zero Defects quality control processes are already an essential element of production, so developing a program to encourage its use should not be a DoD-wide requirement.
    - Contractor Performance Evaluation provides incomplete data that is already well known to those involved in selecting contractors.
        - [This is a counter to previous studies that emphasized the vital importance of designing a communications system for sharing contractor performance evaluations across departments.]
    - Safety Programs are "a newly found and rapidly growing cult which imposes a Government directed program to do things which good development programs logically do."
    - Cost, schedule, and performance reporting requirements tend to become an end unto themselves and do not actually provide cost savings to the programs they are designed to monitor.
    - In replacement of these programs, "There is no substitute for competent and objective surveillance of the critical program elements on a continuing basis."

Manpower / Personnel

- We recommend…serious consideration of establishing a career speciality of weapon systems acquisition management. A major increase in the recognition, the status, and the opportunities in program management may be necessary….

Blue Ribbon Defense Panel, *Report to the President and the Secretary of Defense on the Department of Defense* (1 July 1970: ADA013261).

Summary

This was an enormously ambitious Panel established by SECDEF Melvin Laird, with the entire DoD as its object of study, not just R&D or lab management. When the Panel turned attention to in-house labs, it excluded medical and personnel labs and civil engineering activities, focusing only on labs involved in weapons acquisition processes. The main recommendation of this report for our purposes is that ARPA would be given control over *all* Defense R&D budget activities and would be the key node of laboratory management. NOTE: Subsequent deliberation in 1970 by the Blue Ribbon Committee (established as a result of the report) rejected the ARPA recommendations as inappropriate. Thus, the report's main recommendations for in-house laboratories, which were rooted in strong criticisms of existing management and performance trends, were nullified within 6 months. In place of the ARPA recommendations, the Committee advised DDR&E to undertake a joint review to develop a 5-year plan for major performance enhancement in the Defense R&D system.

The report extensively rehashes recommendations from 1950s and 1960s reports. However, each of the Services officially claimed to have already implemented many of those recommendations years prior to 1970. In fact, the Navy's 1971 report "A Plan for Improving the Effectiveness and Utilization of the Navy's In-House Laboratories" states:

> "…**the evaluations and recommendations offered by the Blue Ribbon Panel were apparently based largely on hearsay** without regard to the purposes for which the Laboratories are maintained, nor their performance of their assigned tasks. To our knowledge, none of the Panel or their staff visited any of the Navy Laboratories nor any of the officials in Headquarters responsible for their operation." (2)

Thus, when it comes to In-House Laboratory management, the Blue Ribbon Panel was unaware that 20 years of reports had already changed de facto R&D management policies in the Armed Services. This lack of understanding is likely a result of the scope of the Panel being much too broad. NOTE: On 26 August 1970 SECDEF Laird announced the appointment of a DoD Blue Ribbon Action Committee to convert the Panel's recommendations into actions as quickly as possible.

Recommendations

Administration / Organizational Structure

- DoD Directive 3200.9 Initiation of Engineering Development should be rescinded. [A step well beyond the DDR&E panel recommendation from 1 year prior to revise 3200.9]
- The position of Director, Defense Research and Engineering should be *abolished*, and his functions reallocated between the Assistant Secretary of Defense for Research and Advanced Technology and the Assistant Secretary of Defense for Engineering Development.
- PPBS should be modified to include the formulation of Research Objectives (ROs) by the Advanced Research Projects Agency
- The Advanced Research Projects Agency should be delegated responsibility for all research and exploratory development budget categories. Funds for such research should be budgeted

directly to his Agency, and the Agency should be authorized to assign or contract for work projects to laboratories of the Defense Department or in the private sector, as appropriate.

- ARPA and Defense Test Agency should conduct joint review of in-house laboratories to determine which are essential and which should be eliminated or consolidated
    - Statute should all or part of proceeds of disposal of existing defense laboratories or centers can be used for construction of a new facility or expansion of an existing one which such construction or expansion has been authorized by Congress
    - Close attention should be given to possible advantages of having some of these laboratories and centers government-owned contractor-operated
- ARPA should be required to provide technical risk assessment on new systems prior to approval of Development Concept Paper
- A Long-Range Planning Group should be created for the purpose of providing staff support to the SECDEF for long-range planning which integrates net assessments, technological projections, fiscal planning, etc….
- Research and Development to advance the technological base should be constituted as a separate program, under the staff supervision of the ASD (Research and Advanced Technology).
    - Responsibility for control of Defense research to advance the technological base should be assigned to ARPA
- ARPA should be responsible for evaluating the effectiveness of all its R&D participants, and should submit an annual Research Objective statement to Deputy SecDEF (Management and Resources) about capability objectives.
- A new development policy should be developed, including:
    - A general rule against concurrent development and production, deferring production decision
    - Use of government labs and contractors to develop selected sub-systems and components on a long-term level of effort basis
    - Less reliance on paper studies in favor of more competitive prototyping
    - Flexibility in selecting type of contract

Contracting

- Discontinue practice of 24-hour advance notice to Congress of contract awards, in favor of concurrent notification with public announcement.
    - [Fascinating. No mention of whether the report was responding to a culture of financial shenanigans, where congress used the advance notification to exploit information asymmetry in stock purchase.]
- Increased emphasis on parametric costing techniques to quantify unknowns
- Patent rights should be clarified in contracts; establish basic categories of data rights
- Deputy Secretary for Evaluation should develop a central control record of contracted studies and analyses that includes subject, purpose, cost, significant findings, and quality assessment of the work. This office should also review Federal Contract Research Centers to determine if their organization needs to be modified or eliminated.

Office of the Director of Defense Research and Engineering, *Defense In-House Laboratories* (September 1970: AD0715213).

Summary

This is an Office for Laboratory Management Report carried out by E.M. Glass while a student at the Center for Strategic and International Studies at Georgetown University. Approximately 8-10 pages from this report appear to be copied verbatim from Glass's 1964 report on the general findings of the Task Force 97 Action Group. Designed as a broad study of US R&D Management, with historical perspective from 1961-70, this report in the end offers 6 broad options for improving Defense R&D Management.

Recommendations

Administration / Organizational Structure

- 6 Optional approaches to improving Defense R&D management and performance
    1) Modified Status Quo [This recommendation involves vague platitudes about reducing duplication of effort and improving inter-service communication.]
    2) Defense R&D Agency (RADA) [Glass offers pros and cons of the last four options in the text, without recommending their adoption.]
        a. RADA would have Office of Defense Research and 8 to 10 centers tailored to mission or functional lines. "Tours of duty" concept could cover university and industry personnel for long periods of time. Recombining center and laboratories in central locations over time.
        b. Office of Defense Research would interface with scientific community at Headquarters and control key laboratories
    3) Higher Level Reporting in the Departments
        a. Labs would report directly to their Asst Secretary for R&D
    4) Defense Institutes Concept
        a. Government Corporation aligned with Bell Report
            i. [Appendix III of this report is a draft bill for Congress, "Proposed Government Institutes Act", developed by the Bureau of the Budget as an implementation strategy for the Bell Report's recommendation.]
    5) Reduction of In-House Laboratory Structure
        a. Requires relying heavily on industry, university, nonprofits
    6) Contract Laboratory Concept
        a. Would require significant buy-in from Congress and President, along with grassroots pressure from countercultural university students

Director of Navy Laboratories, *A Plan for Improving the Effectiveness and Utilization of the Navy's In-House Labs* (Lawson Report) (25 May 1971: ADA555255).

Summary

This report is essentially the Navy's implementation plan anticipating the DDR&E Task Group on Defense In-House Laboratories, published two months later. The main point of this document is that the Navy is capable of fixing its own R&D management problems and meeting the Government's national security objectives once problems have been identified by Executive committees, DoD studies, and Navy internal reviews. I will list recommendations addressed to OSD-level. The goal is to design "Centers of Excellence" that meet all the criteria of optimal "environments" for creative, effective R&D developed in reports from the 50s and 60s.

Recommendations

Administration / Organizational Structure

- Establish Visiting Scientist program between Navy labs and with labs from other Services
- Extend Project REFLEX to all laboratories [i.e. replace manpower ceilings with fiscal controls]

Budget

[These recommendations are designed to permit test/evaluation of design concepts and prototypes before initiating a contract, thus fulfilling the recommendations of the DDR&E Report of the Panel on R&D Management from July 1969]

- Persuade DDR&E/OSD to reduce formal documentation requirements for at least part of 6.3 program
- Increase Independent Exploratory Development funds for lab director discretionary use
- Initiate Independent Advanced Development program

Office of the Director of Defense Research and Engineering, *Report of the Task Group on Defense In-House Laboratories* (July 1971: AD0888515).

Summary

This report, chaired by the same E.M. Glass that was centrally involved in Task Force 97 and other 1960s reports, is concerned with reviewing the 1970 Blue Ribbon Defense Panel recommendations. The report includes the results of JASON Group and Institute for Defense Analyses investigations.

Recommendations

Administration / Organizational Structure

- SECDEF should enunciate the policy that in-house labs should build more working models, or laboratory models, that demonstrate or simulate a proposed system or subsystem. Low-cost demonstration models may be preferred to prototypes
- DDR&E should redefine policies, program structure, and procedures to encourage new initiatives, more flexibility, and greater innovation in advanced development (6.3).
    - One method is to establish "Independent Advanced Development" element for each Service [Navy report from May 1971 already includes this as an ongoing Navy project]
- Military Departments should establish Independent Acquisition Advisory Groups (IAAGs), for independent advice on acquisition programs, composed of lab personnel and other experts not assigned to the program being reviewed
    - IAAGs could advise PMs/SPO directors
- Where creative engineering competence outweighs known requirements, in-house laboratories should be project managers or technical directors of weapons/equipment/systems programs
    - PMs from other programs should be physical located at the laboratories where the expertise they require is found
- Aside from typical test and evaluation, in-house laboratories should perform evaluation/service tests on hardware in early phases of development and acquisition process

Budget

- 6.1 and 6.2 category funds should be exempt from "deferral process" of budget fluctuations and program changes
- If flexibility of DoDI 7220.5 "Research and Development—Program/Budget Costs-Definitions" is not sufficient to permit using RDT&E funds for project-related (not general purpose) facilities and equipment, OSD should sponsor a legislative proposal to amend 10 USC 2353 to permit the same flexibility as provided to DoD contractors' facilities.
- OSD should sponsor legislation to amend 10 USC 2208(c) to provide for reimbursement of working-capital funds for use of unique R&D facilities, which would allow funds for their modification, conversion and replacement to accrue
- Because computers ("automatic data processors") are an R&D tool, dollar ceilings for ADPs in budgets should exempt defense laboratories.
- Excessive auditing needs to be curtailed, and duplication of audit efforts eliminated. Audits could be conducted during a particular month to minimize work load disruption.
- Reprogramming authority must be consistently applied to laboratories and to R&D sponsors

Contracting

- Lab directors should have more control over procurement, streamlined procedures, and higher monetary thresholds
- OSD should revise Armed Services Procurement Regulation to give guidance on procurement in support of RDT&E

Manpower / Personnel

- Lab directors should have more control over personnel management process
- Each year, Departments should remove or reassign the least effective in-house laboratory personnel and replace them with higher quality people. A goal of 5% of technical staff members replaced each year would be reasonable.
- Project REFLEX should expand to cover all labs

MILCON

- OSD should press for increase in minor construction authority from $25K to $50K, with escalation clause for inflation

John L. Allen, Rodney E. Grantham, and Donald B. Nichols, *The DoD Laboratory Utilization Study,* (Office of the Director of Defense Research and Engineering: 28 April 1975, ADA012660).

Summary

The end of the Vietnam War brought on a crisis about how to implement a Reduction In Force (RIF) in the DoD In-House Laboratories. This report attempts to prevent across-the-board cuts to laboratory personnel by recommending cuts to marginal and duplicative facilities, 10 to 15 percent reductions in personnel, modifications in the ratio of in-house to contractor personnel, and further consolidation of Service laboratories into amalgamated Centers. The goal is "to strike a balance between acting responsibly and acting with compassion." The report also examines how to evaluate career paths to determine which personnel should be eliminated while minimizing effects on laboratory performance. Finally, the report reiterates a large number of familiar recommendations from previous studies in order to keep them on the policy-making agenda (removing manpower ceilings in favor of fiscal controls, increased discretionary funds for lab directors, technical information sharing among Services, etc.)

Recommendations

Administration / Organizational Structure

- Initial Technology Base program planning should be done by the Labs themselves
- Laboratories should provide independent risk assessments of proposed programs as a Technical Assessment Annex to the Developmental Concept Paper.
- Each Service should continue amalgamating laboratories into centers allied with distinct technical areas
- Elimination of duplicative and marginally necessary facilities or major portions of laboratories rather than across-the-board cuts over a 2-3 year period
- Continual comparisons with industry and other laboratories should be used as an incentive to the In-House Laboratories to excel, especially in an environment threatening personnel reductions.
- The report examines the feasibility and utility of a single Tri-Service 6.1 Contract Research Program to replace ARO, ONR, and AFOSR, noting pros and cons to the proposal
    - The proposal is rejected due mainly to the argument that revolutionary new ideas are more likely to be overlooked if a single agency has to handle a large volume of research proposals
    - AFOSR and ARO budgets should be increased to a level closer to ONR in order to ensure that alternative trajectories for fundamental research are widely pursued.

Budget

- 6.1 and 6.2 should be block funded
- 6.3 should be task funded, but from 6.3 funds controlled by the Services' Technology Base managers

Manpower / Personnel

- Personnel ceilings at each laboratory should be abolished in favor of fiscal controls established as a dollar ceiling by each Service
- A modified form of the REFLEX program should be used, but with controls over maximum internal operating expenses allowed (i.e. the sum of block funded money that may be expended in-house and the maximum in-house industrially funded business that will be allowed)
- A 10 to 15 percent drawdown in the total laboratory complex should be expected, or between 5500 and 8500 eliminated positions DoD-wide and implemented over a two-year period
    - Attrition will not cover the full needed reduction; an RIF will be required, but every effort to minimize impact on mission performance must be made.
        - [NOTE: In the end, a 10% reduction in force was implemented over a 2 year period, and attrition was the main vehicle.]
- Lab personnel should be encouraged to serve tours in headquarters and on operational staffs
- Continual re-training for lab and headquarters technical staffs is required

John L. Allen, “Statement on Department of Defense Laboratories," Testimony to Subcommittee on Research and Development of House Armed Services Committee (7 April 1977: AD037847).

Summary

This statement attempts to convince Congress that the findings of J.L. Allen et al.’s 1975 *DoD Laboratory Utilization* report ought to be fully implemented. The text is an excellent example of the role of DDR&E as the “Washington Representative” of the DoD in-house laboratories. First, Allen explains to Congress the basic rationale for In-House Laboratories: most importantly, 1) lack of commercial allegiance prevents conflict of interest in weapon system design, and 2) independent assessment of proposed programs is needed in order for DoD to be a “smart buyer” of goods and services. Allen argues that “the basic free enterprise policy of the country” tends to place important system development decisions in the hands of professional Program Managers and external contractors who do not adequately consult in-house laboratory personnel for independent assessments of weapon system design decisions. Allen et al.’s 1975 report recommends steps to stimulate Program/Project Manager utilization of laboratories to ensure DoD’s “smart buyer” status.

Allen argues that restoring the DoD’s in-house system design support function to its rightful place will permit DoD to redistribute R&D funds away from in-house laboratories to universities and independent R&D organizations. From 1965 to 1975, in-house laboratories responded to their diminished role in weapon system development by increasing in-house basic and applied research programs. At the same time, DoD funded 45% fewer scientists and engineers for 6.1 and 6.2 at universities and independent R&D organizations. This imbalanced situation is characterized by an in-house basic and applied research capacity that is “in danger of becoming excessive.” For Allen, this imbalance in relations among industry, university, non-profits, and Services is a consequence of a free enterprise policy displacing the role of the in-house laboratories in “system design support.”

Recommendations

Technology Transfer

- Technology transfer processes are greatly improved if industry already has involvement in the 6.1 and 6.2 activities. Increased funding for contractor support in the Technology Base is advised

Office of Science and Technology Policy, *Report of the Science Advisor's Panel on Basic Research in the Department of Defense* (22 June 1978: ADA103495).

Summary

This Carter Administration report seeks to ensure that DoD's basic research infrastructure "will see us safely enter *the next century* with a national posture, capability, and technological strength appropriate to that age." (1) The recommendations are general: "The Panel did not attempt to pass judgment on the detailed content of the basic research program…." (1) The Panel characterizes the 1960s and 1970s Defense R&D system in terms of a "weakening of the working relationship between the military and the scientific and engineering communities…. At present, the funding of basic research in DOD in constant dollars is about half that of 1966." The report evaluates the status of DoD basic research in a period of rapid economic inflation. The Panel's vision is to increase basic research funding for ten years at a similar rate that basic research funding declined over the previous ten years.

Recommendations

Administration / Organizational Structure

- A senior DoD official reporting to the Deputy Under Secretary for Research and Engineering (Research and Advanced Technology) needs to be assigned full-time responsibility for broad oversight of basic research and needs to serve as focal point inside and outside the DoD for advocacy of the basic research program. "He or she" – [this is the first instance to my knowledge of an official report on R&D management using 'she' to describe a senior manager] – should have a name, record, and stature that automatically comes to mind as the optimal contact between the research community and DoD.
- DARPA should take a role in identifying basic research needs and opportunities, calling them to the attention of the Services, and should the Services desire a long-term commitment, helping with initial funding
    - Special precautions are needed when DARPA wishes to stimulate basic research in some area. It should consult with potential researchers about the time scale needed to produce results. If DARPA is unwilling to commit resources for as long a time as the potential researchers feel is necessary, DARPA needs to make arrangements with one of the Services for assuming longer-term responsibility.
- Research proposals should be selected based upon the perceived quality of the investigator, the originality of the proposal, and by its balance with work already in progress.
- DoD should increase the number of channels through which two-way communication between basic research community and multitude of DoD users takes place. This effort requires more than formal directives or administrative structures at all levels of management.
- SECDEF should vocally endorse President Carter's call for dramatic increases in basic research funding (Carter called for 11% Government-wide increase in FY1979 basic research)

Budget

- Growth in 6.1 budgets should increase for ten years at a rate similar to the rate of decline of the past ten years.

- In areas where urgent gaps in fundamental knowledge need to be filled, e.g. software development and human factors research, DoD needs to make “special arrangements” to stimulate academic interest in these fields of concern.

Congressional Relations

  - DoD should reject a narrow interpretation of The Mansfield Amendment [of the Military Authorization Act], which affected the basic research budgeting process by first requiring all funded research to have “a direct and apparent relationship to a specific military function or operation” and later replacing that criterion with the phrase “…in the opinion of the Secretary of Defense, a potential relationship to a military function or operation.”
    - [NOTE: The US Science committees even today regularly attempt to require basic research proposals to meet specific national security objectives in order to attain funding. The exact same range of responses to such rules can be heard today as in 1978.]

University-Industry-Services Interaction

- DoD must be concerned with the whole national capacity for the conduct of basic research, and strengthen all of its tools for support through grants and contracts, Independent R&D, educational exchange, etc.
- Communication of all new knowledge arising from basic research nationwide is of absolute importance in order for that knowledge to be rapidly put to constructive use

U.S. General Accounting Office, *Federal Laboratory Directors' Perspectives on Management of In-House Laboratories* (15 August 1979).

Summary

This report conveys the perceptions of laboratory directors about systemic R&D management problems, but does not provide its own recommendations, and does not isolate DoD recommendations. GAO surveyed 192 laboratory directors at 8 federal agencies, who described inadequate funding commitments, an eroding foundation for basic research, decreasing staff and inadequate personnel controls, deteriorating facilities and equipment, and insufficient policy frameworks and direction. The GAO report's personnel survey, operational statistics, and rank ordering approach resembles DDR&E's 1971 "Relationships Between Peer Ratings and Quantitative Properties of DoD In-House Laboratories" study, which was written in a very confusing style. GAO's report is *orders of magnitude* more clearly written, with data presentation accompanied by 'Key Points." The report clarifies systemic R&D management problems through a modest focus on summary statistics, whereas the DDR&E attempted to provide predictive insights through elaborate linear statistical methods, accomplishing little and demanding further study.

Deputy Undersecretary of Defense for Research and Engineering (Research and Advanced Technology), *Removal of Institutional Barriers on DoD Laboratories* (September 1979: ADA102544).

Summary

This tightly-focused report responds to over-control of laboratory resource allocation by staff offices and organizations outside the RDT&E management chain by proposing the same recommendation found in every major report since 1962: fiscal controls to replace manpower ceilings. The biggest difference is that this report's recommendations are consolidated into a single "operating concept" with a name: "Integrated Control." The actual policy innovation is incremental: "The essential elements of this proposal are an extension and modification of the Project REFLEX experiment conducted in the early 1970s." (6)

Recommendations

Administration / Organizational Structure

- Implementing integrated fiscal controls at laboratory level will free up Headquarters staff to "more appropriate management responsibilities" such as long range planning and program assessment
    - Integrated Control also will increase fiscal planning stability at Headquarters

Budget

- "Integrated Control": total payroll expenditure ceilings *for civilian employees* should be established for each laboratory, with lab directors making cost-conscious decisions about how best to achieve technical mission objectives through workforce planning, billets, contracting, etc, within those ceilings
    - The PPBE process would proceed as is, with a payroll ceiling itemized for each laboratory replacing scattered programming tools currently utilized. Congressionally approved pay increases would be added as automatic adjustments to these payroll ceilings.

Federal Coordinating Council for Science, Engineering and Technology, *Committee on Application of OMB Circular A-76 to R&D Report: A Research and Development Management Approach* (31 October 1979: ADA323761).

Summary

OMB Circular A-76 was first issued in 1966, and was revised in 1967, 1976, 1977, and 1979. Under the 1979 revision, **all** DoD R&D management decisions would need to be evaluated using OMB's Cost Comparison Handbook. DoD would very frequently be required to submit "detailed explanation, on a case-by-case basis" whenever its R&D resource allocation deviated from A-76's ambiguous definition of inherently-Governmental "core capabilities." Chapter 6 of the report documents DoD's strong aversion to the application of OMB Circular A-76 for R&D management. The report conveys DoD's impression that OMB Circular A-76 would politicize budget programming and entail a drastic increase in Red Tape. The report agrees with DoD's objection; but the report does not make a formal recommendation to the President to exclude R&D from A-76, as making that recommendation would be beyond the scope of its assigned responsibility.

Recommendations

Administration / Organizational Structure

- DoD recommends exempting all R&D activities from A-76 application
- DoD strongly objects to cost comparisons being the primary basis for selecting contract performers and determining the ratio of contractor to in-house R&D
    - This policy would impair the RDT&E manager's ability to provide the best technological capability per dollar expended
- Uniform cost-evaluation criteria for determining appropriate research programs are not desirable for R&D: "Cost is always an important consideration, but it is rarely the dominant factor in R&D procurement decisions." (59)

Congressional Relations

- The House Armed Services Committee fully agrees with DoD's recommendation to exempt R&D from OMB Circular A-76

Robert Kavetsky, Michael L. Marshall and Davinder K. Anand, *From Science to Seapower: A Roadmap for S&T Revitalization* (EPSC Press: 2006).

Summary

This report from an ONR leader, a career Navy R&D policy planner, and a university professor makes a forceful case for expanding in-house RDT&E capabilities in the Department of Defense. It examines global R&D funding and workforce trends with particular emphasis on DoD's aging S&Es, re-evaluates what attributes make an optimal research environment in this R&D landscape, and foregrounds the importance of visionary leadership in motivating experiments with institutional change. The report's most vocal recommendation is to expand DoD educational funding by orders of magnitude and rethink military career planning – 4,000 additional PhD dissertations in 10 years for the Navy alone, with changes in career planning that require aspiring journeymen to obtain PhDs. Many of its recommendations are DoD-wide, and those addressed to the Navy can be viewed as examples for utilization DoD-wide. It is a concise document with a sustained tone of urgency.

Recommendations

Administration / Organizational Structure

- US Government, through DoD advocacy, should create a DoD S&T Academy, equivalent in prestige to the National Academies of Science and Engineering
- Launch an aggressive DON-wide program to ensure inter-generational transfer of corporate knowledge
- Establish SES-level Technical Director positions at the warfare/systems center division sites, responsible for the entire technical output of the organization
- Create an S&T Governance Council chaired by ASN(RDA)

Budget

- Increase DON S&T budget to 3% of DON Total Obligation Authority
    - Reallocate funds among academia, in-house centers, and industry to ensure viability of each sector
- Provide a $50 million laboratory and equipment-funded source in the DON S&T account to be focused on S&T frontiers

Education

- DON should fund 4,000 PhD dissertations in 10 years on matters of greatest long-term urgency
- DON should institute a career path to journeyman level that requires obtaining a PhD

Manpower / Personnel

- DON should hire 500 S&Es per year for ten years to work on vital R&D projects
- Institute military career paths for "Military Technology Officers"

William Berry and Cheryl Loeb, *Breakthrough Air Force Capabilities Spawned by Basic Research* (National Defense University Center for Technology and National Security Policy: April 2007).

Summary

Overall, this report reiterates the importance of long-range, high-risk basic research investments by providing vignettes of historical basic research and ongoing basic research that may provide revolutionary capabilities for future operating environments and commercial enterprises. Four areas are covered: autonomous, unmanned vehicles; identifying, tagging, and tracking entities; getting to an area of operations faster; and assured cyber engagement. The report utilizes a classic conception of basic research as supplying the raw materials for applied developments and integrated systems.

This short report is actually quite rare among commissioned reports in suggesting that scientists and engineers developing revolutionary products need to be empowered to influence public policy discussions related to the social and legal implications of the future military capabilities and commercial industries their research may enable. (See page 22-23) This emphasis arguably works best alongside recommendations for DoD to produce a National Academies-style Science and Technology Academy that would permit the most talented in-house S&Es to address public policy questions arising from in-house research, e.g. as recommended in Kavetsky et al. 2006, *From Science to Seapower: A Roadmap for S&T Revitalization.*

J.E. Hazell, *From Reform to Reduction: Reports on the Management of Navy and Department of Defense Laboratories in the Post-Cold War Era*, (Washington DC: National Defense University: 2008).

Summary

This detailed summary and evaluation of 65 official reports from a professional historian and Naval R&D staff member is not intended to endorse specific recommendations, but to provide general reasons for maintaining an internal technical expertise at DoD in-house laboratories. It provides inside information not presented in the official reports it summarizes. Hazell's historical insight is that periods of intense managerial reform inevitably lead to periods of intense push-back, where policy-makers realize, for example, that free-market downsizing and reliance upon contractors diminishes DoD's overall ability to function as an independently-minded "smart buyer." As a result, Hazell expects a period of resurgence for DoD in-house laboratory RDT&E activities over the next decade.

The text provides a concise overview of the main managerial questions that organize post-Cold War reports: hiring and retaining S&Es, advocating for laboratory needs at senior leadership levels, maintaining facilities and equipment at state-of-the-art levels, deciding on the best corporate management form [e.g. GOGO, GOCO, Government Institute, etc], providing discretionary budgets for lab directors, removing Red Tape / streamlining S&T management, balancing long-term and short-term research needs, finding an optimal in-house personnel/contractor ratio, and developing appropriate means of measuring ROI for R&D.

John W. Lyons, Richard Chait, and Jordan Willcox, "An Assessment of the Science and Technology Predictions in the Army's STAR21 Report," National Defense University Center for Technology and National Security Policy (July 2008: ADA485442).

Summary

This study reports the results of in-house interviews with senior Army research staff designed "to assist the Army in improving its ability to incorporate advanced technologies into its weapons, equipment, and doctrine." The goal is to evaluate the technical assessments of future military capabilities presented in the National Research Council's STAR21 report, completed in 1992. The STAR21 report attempted to look 30 years into the future, which "is very likely *too far* into the future," since technologies advance at very different rates. Not surprisingly, the study finds that many of the most transformative long-term research trends and technical developments since STAR21 were either entirely missed or under-estimated in the NRC report, while the importance of other topics were over-estimated. Nevertheless, the report finds that conducting these technical assessments can motivate innovative system design concepts, and suggests that the Services jointly fund periodic scans of the technological horizon.

Timothy Coffey, *"*Building the S&E Workforce for 2040: Challenges Facing the Department of Defense," National Defense University Center for Technology and National Security Policy (July 2008: ADA485441).

Summary

The most important recommendation of this report is to permit S&Es working on 6.1-6.3 programs to transfer to 6.4-6.7 programs as the work they perform matures into major end-items. (18) The report's recommendations are minimal and generalized, and are buried in the text.

The report traces S&E workforce trends from 1929 to 2006 to contextualize "disturbing" contemporary trends in DoD S&T spending relative to national and international R&D trends. Once again, the NDU author utilizes the 1962 Bell Report as an exemplar text to motivate contemporary policy actions. Using an admittedly "oversimplified" mathematical equation to project a 125-year timeline out to 2040, the report suggests that DoD S&T spending as a percent of national GDP will drop precipitously in coming decades, as will DoD in-house S&E workforce levels compared to national S&E workforce levels. Similarly, DoD civilian S&E positions are exponentially decreasing when compared to contractor positions (termed a "Shadow Government Workforce"), jeopardizing national security by eliminating the in-house S&Es that ground DoD's "smart buyer" capacity. The report suggests that DoD recognize and reverse these trends immediately while adapting to the demands of a new generation of S&Es, providing meaningful missions to in-house personnel who want long-term mobility across laboratories and frequent collaborative interactions on the job.

Recommendations

Administration / Organizational Structure

- DoD must make concerted efforts to harness S&E workforce expertise for long-range S&T planning as this expertise co-evolves with emerging disciplinary boundaries in the national and international S&E workforce

Budget

- DoD civilian S&E workforce should not only track the defense base program as a percentage; it should also match the emergence of new disciplinary foci in the national S&E workforce over time.

Manpower / Personnel

- Evolve the S&T discipline makeup of the DoD S&E workforce
- Permit 6.1-6.3 personnel to transfer to 6.4-6.7 activities as the work they perform matures into end-items

Albert Sciarretta, Richard Chait, Joseph Mait, and Jordan Willcox, "A Methodology for Assessing the Military Benefits of Science and Technology Investments," National Defense University Center for Technology and National Security Policy (September 2008: ADA487270).

Summary

This report does not offer recommendations, per se. It attempts to respond to the inadequacy of commercially-focused methodologies for measuring the return on investment for military basic research in an era of globalized R&D production and Joint-Service operations. It sketches out some basic criteria that a good analytic tool would possess, including the importance of valuing long-term, high-risk basic research investments that commercial Net Present Value calculations might discount. Its "recommendations" are model-centric rather than organizational, i.e. they are focused on broadly sketching analytical requirements, subjective metrics, quantifiable metrics, and documentation standards for DoD assessments of S&T programs. The design criteria described in the report are already well-established in cost estimation, operations research, and systems analysis (Benefit-Cost-Ratio, the "Jimmy Stewart test," measures of performance / merit / effectiveness). The report's basic goal is to provide background considerations for a "use case analysis" of autonomous systems development, to be published at a later date. It is thus a provisional report.

William Berry, Timothy Coffey, Donald DeYoung, James Kadtke, and Cheryl Loeb, "Reform of the National Security Science and Technology Enterprise," National Defense University Center for Technology and National Security Policy (October 2008: ADA489377).

Summary

In preparation for a new Presidential Administration, this report aims to directly address its recommendations to presidential *candidates*, to DoD leadership, and to Congress. Unlike most reports, it includes recommendations to restructure Congressional committees for improved S&T planning. The report's topics are 1) how senior S&T advisors can improve priorities determination and implementation, 2) how to integrate Congressional committees that oversee and fund S&T, and 3) how to improve the competence, role, and impact of the S&E workforce. The report's style and recommendations are largely identical to those made by Donald DeYoung in various National Defense University documents from this period. The basic strategy is to view the 1962 Bell Report as an exemplar text that allowed Kennedy and Nixon to reverse an excessive trend toward permitting contractors to oversee major end-item acquisition. This historical model becomes the basis for a policy agenda to restore the balance that was established in the 1960s and lost in the 1990s.

Recommendations

Administration / Organizational Structure

- Executive Branch Reforms
    - Rapidly fill the positions of Science Advisor to the President and Director of the Office of Science and Technology policy and accelerate the appointment of the senior scientific advisors in the departments and agencies
    - Fill all four OSTP Associate Director Positions and assign them to joint positions in key Executive Office components, such as OMB, NSC, HSC, and NEC
    - Increase OSTP staff so personnel can fulfil the OSTP mandate to cover "regulatory, fiscal, legal and business environment policies that impact the innovation process"
    - Develop with Congress a National Security Science and Technology Strategy and use it to set priorities for NSST and to direct agency resourcing and implementation
- Congressional Reforms
    - Reorganize Congressional committees to explicitly include NSST and to create parallel committees in the House and Senate
    - Create inter-committee task forces to develop a long-range NSST Strategy (with the Executive Branch) and address issues of high importance to NSST
    - Create a standing Congressional-Executive NSST Forum to address NSST issues, including working budgets with OMB
    - Ensure programs are authorized before appropriations are approved to provide technical review and reduce the deleterious impacts of earmarking
    - Improve Congress's access to good technical advice by creating an OTA-like organization as well as an NSST caucus
- Government Science and Engineering Workforce Reforms
    - Divide the Senior Executive Service into an Executive Management Corps and a separate Professional and Technical Corps
    - Provide for "direct appointment without competition" authority for NSST positions

- Permanently implement the eight DoD laboratory demonstration projects using all the authorities contained in Section 1114 of the NDAA for FY01
- Institute incentives to preserve the technical competence and capabilities of the Government's NSST S&E workforce
- Create an interagency team, similar to the one that conducted the 1962 Bell study to determine what is "inherently governmental" and the consequent roles of the government's NST S&E workforce

Richard Chait, “Perspectives from Former Executives of the DOD Corporate Research Laboratories,” National Defense University Center for Technology and National Security Policy (March 2009: ADA496468).

Summary

This report documents the attitudes of former laboratory directors (ARL, NRL, AFRL) concerning laboratory management. The former executives reinforce the recommendations of various reports, for example, that a strong in-house S&E workforce can prevent costly acquisition mistakes by critiquing defense contractor technical claims, acting as an “honest broker” to make DoD into a “smart buyer.” The report itself only provides recommendations related to utilization of these experts in National Defense University courses and as sources of insight for future in-house laboratory managers.

Recommendations

Administration / Organizational Structure

- DoD should develop a single forum where in-coming senior S&T in-house laboratory managers can tap the extensive wealth and knowledge of former laboratory executives

John W. Lyons and Richard Chait, "Strengthening Technical Peer Review at the Army S&T Laboratories," National Defense University Center for Technology and National Security Policy (March 2009: ADA496467).

Summary

This report renews the BRAC-era push to produce independent technical assessments of laboratory activity at each of the DoD labs. "This paper recommends that the Army require peer review of the technical quality of its laboratories and proposes a set of norms that must be met. The principal recommendation is that reviews be performed by independent experts who visit the laboratory for two or more days, looking at the technical projects and the strength of the technical staff, equipment, and facilities. The recommendations include a caveat about potential conflicts of interest in these panels."

Recommendations

Administration / Organizational Structure

- DoD policy should require Army S&T laboratories to empower outside groups to convene peer review panels and manage the review process
    - The policy should point out the enhanced credibility of panels that are so convened
    - The reputation of the contractor should be an important factor in the selection process
    - Specific steps should be taken to ensure that conflict of interest on the part of the proposed experts is dealt with either by disqualifying the candidate or, in the case of very small pools of available experts, making the potential conflict known in advance and achieving balance by selection of the other members
    - Laboratory managers may suggest panel members but should not control the appointments
- The policy should require that the reviews themselves be done by panels of experts external to, and independent of, the laboratory
    - The panels should consist of researchers in the same fields drawn from academia, industry, research institutes, and other government laboratories for review of technical quality
    - The panels should have both technical experts and representatives of the user, such as program executive officers and program managers and the TRADOC, for review of relevance
- Reviews should be done every two or three years
    - The annual review process should be staggered such that any one area is only reviewed every two or three years to spread out the burden of handling the reviews
- The reviews should cover technical details at the project level
    - Enough time should be allowed for the panel to hear many different project presentations, selected to give a true picture of the laboratory's work
    - Have separate panels for each major segment of the laboratory program to provide good coverage of the laboratory programs
    - Panels should be allowed to spend two or more days in review
- The panels should also assess the quality of the staff, the management environment, and the facilities

    - Can be completed by encouraging panel members to walk through the laboratory or talk to staff
- The panels should provide feedback to the laboratory staff and prepare formal written reports
    - Reports should be submitted to the laboratory management, and copies provided to relevant members of the chain of command
    - Copies of the report should be filed in the DAS(RT) office
    - Laboratories should be required to respond to panel recommendations or critiques at the next meeting

William R. Fast, Alan Jenkins, Mike Kotzian et al., *Defense Acquisition Review Journal. Volume 16, Number 1, Issue 50,* Defense Acquisition University (April 2009: ADA496932).

Summary

This edited collection of award-winning essays focuses on adapting new human resources strategies for a 21st century acquisition system characterized by a global "war for talent." The most vocal policy recommendation is for DoD to begin a large telework pilot study. A variety of analytic frameworks are applied to workforce data sets and historical case studies to produce qualitative and statistical insights into workforce retention, telework policy, and training & certification that suggest ways to improve the quality of DoD S&E workforce recruitment and retention.

Recommendations

Administration / Organizational Structure

- DoD must focus on long-term, intangible strategies focused on developing leaders who better understand how worker psychology and aspirations align with laboratory mission
    - DoD *will not achieve* improved acquisition workforce retention by focusing solely on short-term tangible incentives like pay, benefits, physical workspace, teleworking, etc.
- DoD should integrate Systems Engineering and Lean Six Sigma as an organizational problem-solving tool, operated by multidisciplinary collaborative teams
    - The combined efforts of these approaches could permit dramatic performance improvements in S&T programs

Manpower / Personnel

- DoD should experiment with telecommuting pilot studies, beginning in offices with less than 350 employees
    - 25% of personnel in these offices should telecommute: either 25% of employees full-time telecommuting, or 25% of overall work-hours for organization allocated to all employees
        - DoD should measure the effects of this pilot project in detail, comparing results to the US General Services Administration's Telework Technology Cost Study
- Managers should measure employee performance by results, not physical presence
- Education, training, and certification standards for acquisition workers must be taken more seriously by DoD leadership to ensure more complete compliance by workers
- The next generation workforce demands to be mobile, with 2-5 year rotations and exciting projects to work on, with frequent opportunities for growth and development, and a culture of recognition that confers deep meaning on high-quality work

Don J. DeYoung, “Breaking the Yardstick: The Dangers of Market-based Governance,” National Defense University, *Defense Horizons*, May 2009, ADA499585.

Summary

This article calls for restoring a balance between in-house and contractor R&D that was established in the 1960s by implementing recommendations of the Bell Report. It claims that the necessary steps to restore DoD’s “Smart Buyer” capacity are “well known, well understood, and solvable” and provides five solution options dealing with organizational structure, manpower / personnel, and budget. The culprit in this article is a decades-long trend toward *excessive market-based governance* of DoD in-house laboratories (i.e. outsourcing, downsizing, and inappropriate centralizing of R&D management).

Recommendations

Administration / Organizational Structure

- Divide SES into an Executive Management Corps (EMC) and a Professional and Technical Corps (PTC)
    - EMC and PTC must be equivalent in rank to general/flag officers
    - PTC personnel should run the DoD in-house labs
- Restore to civilian lab directors all authorities lost over past decades
    - Authority to make program and personnel decisions, allocate funds
        - Facility management authority, direct hire authority
- Restore dual-executive relationship of military and civilian leadership at all labs

Budget

- Create a separate R&D military construction budget

Manpower / Personnel

- Exclude lab personnel demos from National Security Personnel System permanently, while allowing demos to expand and continue producing new personnel management concepts

Defense Business Board, *Report to the Secretary of Defense -- Assessing DoD's Study Information Gap: Optimizing the Electronic Management of DoD-Related Studies*, April 2010, ADA526146.

Summary

This fascinating and forgotten report urges DoD to expand the capabilities of the Defense Technical Information Center into a DoD-wide Defense Knowledge Management repository covering all DoD-funded and DoD-related studies, including open source analyses published by think tanks, independent scholars, and foreign militaries. The management system, loosely modeled on the THOMAS.gov database of the Library of Congress, would permit personnel to search through *all* recommendations made in both technical and non-technical studies, including the rationales and supporting data for those recommendations. The repository, which the report names "ATHENA," would be implemented through increases in DTIC funding, and would include DTIC's current technical repository as a subset. The overarching goal motivating the project is to optimize sharing, research, and collaboration among past and current studies. The report recommends that a business case analysis be conducted immediately, and that preliminary implementation of the ATHENA repository be completed ***within 6 months*** by a team of 10-15 engineers.

Recommendations

Administration / Organizational Structure

- **Preliminary implementation of all recommendations in this report should be accomplished through a 6-month project performed by 10-15 engineers**
- Deputy Secretary of Defense should officially designate an electronic Defense Knowledge Management repository for all DoD-funded studies and DoD-related studies, building upon current DTIC capabilities
    - All DoD-funded and DoD-related studies should be required to be submitted to this central repository
    - Require all initiators of DoD-funded studies to register for a DoD study number at the time of contract award (similar to Library of Congress assignment of copyright)
    - Establish a monitoring / enforcement mechanism for submissions to this central repository, with penalties such as final payment withholding for noncompliance
    - Ensure ability to pull from full text (DTIC is currently attempting this) and not just abstracts
- Potential re-naming of the system to **"ATHENA"** that more accurately reflects the broad knowledge management mission beyond technical documents
    - Consider maintaining DTIC name for the technical portal of ATHENA
- Issue a new Deputy Secretary of Defense directive
    - Expanded "ATHENA" system will be searched prior to initiation of new studies and rationale be provided as to why prior related studies are insufficient
    - All new studies are required to include hyperlinked references to previous DoD-funded and DoD-related studies – all studies not appearing on "ATHENA" must be forwarded to populate the database
    - A designated officer be named to track all "New Studies in Progress"

- Assign “ATHENA” team members to interface with OSD, Joint Staff, Services, Defense Agencies, DoD Advisory Boards, and other organizations to build a client base of motivated users and collaborators who facilitate submission of studies

Budget

- Sufficiently resource DTIC to achieve central repository (“ATHENA”)

Contracting

- Select a commercial provider of ongoing and updated search algorithms
  - Establish and codify a taxonomy for proper input of studies in the system to facilitate improved searches
    - Use nomenclature like THOMAS.gov search engine at Library of Congress

Further Studies

- Conduct a business case to identify one-time costs and ongoing costs to enable the above enhancements (i.e. to fund ATHENA)

JASON, *S&T for National Security,* Released 13 May 2010 to the Federation of American Scientists following a FOIA request and appeal to the DOD. ADB360036.

Summary

This Summer 2008 study suggests the need for significant modifications in DoD S&T activities, including the elevation of DDR&E to an Under Secretary of Defense for Science & Technology. The report identifies a problematic drift toward short-term, deliverable-based basic research in the Services. Since "DoD is not effective in coordinating and overseeing the basic research program" (29), the report recommends that DDR&E create a Basic Research Advisory Committee to understand and shape the Services' 6.1 programs – a recommendation that may have influenced the DBRAG component of the Reliance 21 Operating Principles. The report suggests that each Service establish a Research Corps, and that all DoD in-house laboratories maintain some dedicated 6.1 research staff whose research conforms to traditional conceptions of basic research. The report finds DoD's graduate educational pipeline inadequate and recommends improvements. Finally, Appendix B offers a remarkable refutation of what the report calls "seductive," "fallacious," "neo-conservative" arguments about the Net Present Value of long-term basic research which suggest that short-term, deliverable-based basic research is more valuable to DoD than long-term basic research. The report claims that these arguments ignore DoD's central role as the primary market-maker in future national security environments. Rather than redefine "6.1 research" to accommodate a broad near-term capabilities focus, as is the practice of many contemporary reports, the JASONs call on DoD to reject these "quasi-economic" arguments and return to the pursuit of a genuine, revolutionary 6.1 research agenda.

Recommendations

Administration / Organizational Structure

- DoD should consider redefining and elevating the DDR&E position to an Under Secretary for S&T, separating the research and acquisition functions
    - This would provide an informed technical voice at the highest levels of DoD, greater visibility of S&T within the Department, and more focused management attention on S&T
        - [NOTE: In January 2011 President Obama established the Assistant Secretary of Defense for Research & Engineering within the Under Secretary of Defense (Acquisition, Technology, and Logistics), a re-organization that was orders of magnitude less ambitious than the proposal offered by the JASONs.]
- DoD should create a basic research advisory committee reporting to the USD(AT&L)
    - Committee should include external members from academia and industry
    - Committee would review and advise annually on the health of DoD basic research and serve as an institutional memory for 6.1 activities.
- Line acquisition and operational leaders **should not have** decision authority over the 6.1 budget
- Technically-savvy program managers should be given wide latitude in 6.1 funding decisions and in evaluating researcher performance
    - Peer review as the primary mechanism of funding decisions (as with the National Science Foundation) discourages revolutionary advances
        - This approach produced the greatest successes historically; yet, the long-term focus of this management strategy may appear to have a low Net Present Value

compared with a project-based, peer review funding process. As a result, decades of Congressional pressure and performance-based metrics incentivize a drift toward deliverable-based short-term 6.1 projects. This should be resisted.

Education

- Undergraduate outreach and summer internships are preferable to scholarships
- Expand (with improvements) the National Security Science and Engineering Faculty (NSSEFF) Program

Manpower / Personnel

- DoD should establish a Research Corps within each service to address chronic S&T personnel issues
    - Routine rotations across service boundaries should become normal career progress, in line with the model for joint service that DoD has adopted
    - Promotions should be based on contributions to national security, beyond service needs

University / Industry / Services Interaction

- DoD needs to grow in-house experts and link them with experts in the academic and for-profit sectors
- DoD should provide research leaves of absence for lab personnel to work in academic, industrial, or other government labs, along with hosting academic researchers

National Academies of Science, *Examination of the U.S. Air Force's Science, Technology, Engineering, and Mathematics (STEM) Workforce Needs in the Future and its Strategy to Meet Those Needs*. Air Force Studies Board of the National Academies (May 2010).

Summary

This report focuses on Air Force organization, budgeting, contracting, education, and personnel practices that provide an overall STEM-degreed and 'STEM-cognizant' organizational mindset. Many of the recommendations are directly relevant to OSD policy planners, even though the recommendations are directed at Air Force decision-makers.

Recommendations

Administration / Organizational Structure

- OSD's Defense Acquisition Workforce Improvement Act (DAWIA) policy should include 'STEM-cognizance' as a minimum requirement for program management certification, and should clarify which STEM positions are critical acquisition positions (CAPs)
    - If OSD does not change its DAWIA policy, Air Force should unilaterally change its own implementation
- The Air Force Strategic Plan should include recruiting, developing, and retaining STEM skills and experience as a key objective of weapon system R&D and acquisition.
- Air Force should establish a STEM Council as a sub-council of the Force Management & Development Council to review policies and implementation, make recommendations on STEM accessions, utilization, and competencies across all Air Force missions, organizations, and career fields.
    - Council should determine minimum requirements for STEM-cognizance for program managers (e.g. 30 hours of STEM coursework without obtaining degree)
- Military Deputy to the Assistant Secretary of the Air Force for Acquisition should be functional advocate for all STEM personnel
- Air Force should develop a decision support model, analogous to Rated Management Decision Support System, to predict future requirements, inventory, and impacts of personnel policies and decisions (including manpower reduction), for the aggregate needs of maintaining technical competency in overall Air Force
    - Deputy Chief of Staff for Manpower and Personnel should oversee STEM decision support tool
- Air Force Institute of Technology (AFIT) should consider providing graduate-level STEM education at the resident school, civilian institutions, or through on-line or other decentralized education modes, along with continuing education in STEM disciplines for STEM-degreed personnel

Budget

- Air Force should consider moving the acquisition workforce from the operations and maintenance funding line (Account 3400) to the RDT&E funding line (Account 3600), in order to address uncertainties in civilian workforce funding and thereby improve employment and workforce stability

Contracting

- To bring more required expertise in-house, Air Force should consider converting contract dollars currently allocated to contracted engineering talent into funds for civilian engineering authorizations

Manpower / Personnel

- An explicit demarcation of what counts as a STEM degree is needed for personnel purposes
- Aside from STEM degrees, STEM capabilities should include “STEM-cognizant” personnel who have a certain number of hours of STEM coursework but have no degree. Both STEM-degreed and STEM-cognizant personnel are needed in the acquisition and intelligence communities, and emerging domains of space and cyberspace.

Naval Research Advisory Council, *Summer Study on Status and Future of Naval R&D Establishment,* (September 2010: ADA532609).

Summary

This extensive technical report from the U.S. Naval Research Advisory Committee Panel on the Status and Future of the Naval R&D Establishment grimly claims that "the Warfare Centers are in a slow 'death spiral' of diminishing technical competence." To motivate deep institutional change, the report isolates mixed messages coming from DoD leadership, focuses on a serious long-term risk arising from the Working Capital Fund (WCF) model of laboratory operations management, identifies significant capability gaps in data management for weapons systems, and makes specific recommendations in a wide range of technical capability areas.

The serious risk arising from WCF models is worth noting, due to its wider relevance to the Defense Laboratory Enterprise. According to the report, since WCF customers are seeking to meet short-term and mid-term requirements, long-term 6.1-6.3 funding is falling to very low proportions of overall laboratory spending in these warfare centers, which diminishes long-term technical expertise. Less than 1% of reimbursable expenditures at WCF-operated warfare centers went to 6.1-6.3 in immediately prior years, and of the 6.1 projects funded, a majority may not qualify as genuine long-term 6.1 research. Meeting near-term customer needs, combined with the WCF's pursuit of non-profit year-end net operating expenses, dis-incentivizes long-term research planning. Lack of discretionary funding for long-term research makes these WCF warfare centers ill-prepared to contribute to future military capabilities.

The WCF critique is particularly interesting since DoD has occasionally gestured toward migrating all DoD labs toward WCF models, even going so far as to mandate WCF migration in the 1998 DOD Program Budget Decision 411C. PBD 411C was withdrawn by the DoD Comptroller prior to implementation. If the JASONs are correct that there is a problem, it would seem to warrant continual study.

Recommendations

Administration / Organizational Structure

- Establish NRL as a place for development and experimentation of the methods to scout, shape, and exploit global technology
- Establish an office of primary responsibility for the management of R&D for the Navy-After-Next
- Designate a Director of Naval Research & Development Establishment
- Conduct biennial, independent assessments of NRDE technical capabilities led by ASN (RDA)
- Influence external research agendas to narrow capability gaps
- Senior management salaries need to be more competitive
- Consolidate HR, MILCON, and maintenance (NRL and warfare centers) under a single Regional Commander for MILCON & maintenance, and single regional HR Office for HR

Budget

- Utilize Section 219 funding to the fullest extent possible

Manpower / Personnel

- Increase number of technical SES and ST billets to Naval warcenters
    - Current perception is that program management offers greater promotion opportunity than technical achievement
- Workforce mobility pilot program – exchange among industry, academia, NRDE
    - This becomes increasingly important over time, since “Generation Y” / Millenials are less attracted to ‘jobs for life’ and will thus be sympathetic to productive, hands-on laboratory rotations

Lyons, John W Chait, Richard, *Assessing the Health of Army Laboratories. Funding for Basic Research and Laboratory Capital Equipment*, National Defense University (September 2010: ADA528880).

Summary

This report's basic insight is that all laboratories should have active basic research programs, irrespective of whether their mission is geared toward advanced development and systems design. It argues that at least 15% of total laboratory funding (not including customer money) should go to budget activity 6.1 in laboratories with a significant basic research focus, with 75% of that funding (or 10% of overall budgets) being controlled by lab director discretion. Laboratories without an explicit basic research mission should nevertheless have at least 5% of total budgets going to 6.1, with distinct basic research programs occurring in each of the lab's research divisions (at least two senior investigators). The report admits that its laboratory capital equipment analysis is unsound: "If the Army wishes to establish a sound basis for program planning and budget we believe a detailed study involving an in-depth accounting process would be necessary." (12) It attempts to provide a recapitalization rate based on total average facilities and equipment lifespan costs at specific laboratories, leading to strange figures that have no relevance to the task of managing recapitalization by adapting to the rapid pace of scientific advancement. For example, the report suggests **68** and **180** year recapitalization rates for NRL and ARDEC, respectively.

Recommendations

Administration / Organizational Structure

- Basic research and capital equipment funding should be special topics covered in the submission to the Army Research and Development Laboratory of the Year competition

Budget

- 6.1 budgets should increase enough to provide at least two senior investigators for BA 6.1 activities in each research division of every DoD in-house laboratory
    - ILIR funding is insufficient to provide for this capability

Facilities / Equipment

- A thorough "audit of the books" is needed to understand recapitalization, separating capital equipment from facilities upgrades, etc.
    - [Notably, subsequent reports have identified significant obstacles to conducting such audits. Standard metrics of facilities and equipment costs do not, for example, convey the mission-critical urgency of upgrading equipment to adapt to the advance of emerging technologies. The rank ordering process for upgrades at installations cannot currently accommodate this science-centric insight.]
- DDR&E and ASA(AL&T) should establish standardized definitions for laboratory capital equipment

Manpower / Personnel

- Performance reviews of managers should include basic research and capital equipment funding items

Institute for Defense Analyses , *Department of Defense Laboratory Civilian Science and Engineering Workforce – 2011,* (May 2011: ADA590174).

Summary

This descriptive IDA / Diligent Solutions report, responding to a request from the Director of the Defense Laboratory Enterprise, uses Defense Manpower Data Center data to determine the size and composition of the civilian S&E workforce in DoD in-house laboratories, and attempts to isolate trends in workforce data. Six data points are considered: laboratory location; occupational job series; education level; age; race; and gender. The report's projections for 2020 are based on an assumption of a 5% linear personnel reduction. The report also compares data on S&E international migration trends through a 2010 National Science Foundation indicator report, Census Bureau data, and OECD reports.

Recommendations

Manpower / Personnel

- Since 1/3 of civilian S&Es will be eligible for retirement in 5-10 years, "DoD will need to examine its recruitment and retention efforts"

Center for Strategic and International Studies, *The Defense Department's Enduring Contributions to Global Health – The Future of the U.S. Army and Navy Overseas Medical Laboratories*, (June 2011)

Summary

This document holds insights for strategic communications and public relations related to laboratory management. While subsequent reports recommend DoD to increase its overseas R&D presence in response to globalization trends, this well-organized report documents the positive public health impacts of existing DoD overseas medical laboratories. Its recommendations focus heavily on urgent budget increases and on exploiting information and communications technologies (ICTs) for improving laboratory management. The report calls for the development of sophisticated public relations and social media campaigns to improve visibility of the public health outcomes of overseas laboratory research.

Recommendations

Administration / Organizational Planning

- Greater integration and collaborative planning
    - Exploit new teleconference technologies
- DoD should undertake an initiative (combining NMRC and WRAIR) to chart how future laboratories might best respond to urgent medical research demands that arise unexpectedly in different regions
    - Initiative should consider the prospect for developing new regional operations

Budget

- Congress should provide the programmed funding necessary to maintain the laboratories' core scientific capabilities
    - Overseas laboratories are $22-25 million short of the annual funds required for equipment, maintenance, and local personnel
- Congress should provide $20 million additional funding for core research projects
    - Specifically, Military Infectious Disease Research Program (MIDRP) should receive additional funding specifically targeted to support these projects in overseas laboratories
    - It would be counterproductive to merely reprogram MIDRP funding toward overseas labs while offsetting that funding with decreases in other Army and Navy medical research activities

Manpower / Personnel

- Army and Navy should modify personnel requirements for medical researchers
    - 5 years or longer tours of duty would minimize disruptive effect of turnover
    - A dedicated career track in medical research, along with joint assignments with other agencies such as CDC, would incentivize high-risk overseas deployments by providing significant potential rewards for top scientific talent

Public Relations

- The laboratories should make a concerted effort to increase the visibility, understanding, and support of DoD overseas research programs among key target audiences. Initiatives should include:
    - Creating an annual forum on DoD Overseas Medical Research

- Working closely with DoD's legislative liaison staff to increase Congressional awareness of the laboratories' activities
    - Regular appearances by lab leadership on Capitol Hill (including private consultation to authorization and appropriation committees)
    - Focused effort to bring Congressional Delegations to overseas laboratories, and to show congresspersons the central WRAIR and NMRC labs near Silver Spring, MD.
    - Presenting the laboratories' work in person to authorizers and appropriators is invaluable
- Reaching out to current and prospective business, university, and foundation partners, as well as other USG agencies
    - A polished, user-friendly annual compendium of successes that makes an easily understood, quantitative case for the laboratories as a useful research platform
        - To achieve this, laboratories need clearer metrics
            - E.g. number of U.S. and allied soldiers inoculated or treated with products the laboratories developed
    - **Laboratories need a unified Internet and social media strategy**, including specialized media training for officers in each laboratory and targeted electronic outreach to the laboratories' many scientific alumni
        - A single, unified set of documents, presentations, and Internet resources should be made available to DoD, Congress, and external partners

Samuel Musa, Richard Chait, Vincent Russ, Donna Back, *Strengthening Government Laboratory Science and Technology Programs: Some Thoughts for the Department of Homeland Security,* National Defense University Center for Technology and National Security Policy (July 2011, ADA548892).

Summary

This short report uses DoD laboratory managers' leadership traits to generate simple recommendations for DHS laboratory leadership. Its recommendations involve balancing short-term and long-term research, interagency coordination, and quick response to new urgent requirements.

Recommendations

Administration / Organizational Structure

- Laboratories should produce a self-evaluation using metrics developed by the 1991 Federal Advisory Commission on Consolidation and Conversion of Defense Research and Development Laboratories, i.e.:
    - Laboratories must have clear and stable missions
    - Laboratories must have highly competent and dedicated workforce
    - Laboratories must have highly qualified and empowered leadership
    - They should have state-of-the-art equipment and facilities
    - Labs should have close relations with the user/customer
    - Laboratories should have a strong basic research component
    - There should be budget stability for the laboratories
    - There should be a champion in senior management above the laboratory
    - There should be strong ties to other laboratories inside and outside the government

University / Industry / Services Interactions

- Peer reviews of laboratory research programs should be conducted, if possible by world-class scientists such as Nobel Laureates, to identify strengths and weaknesses, as well as potential areas of collaboration with other internal and external laboratories in government, industry, and university.

RAND, *Improving Army Basic Research: Report of an Expert Panel on the Future of Army Laboratories* (January 2012: ADA559283).

Summary

The most important methodological insight of this report (p. 17) is that analyzing broad trends in U.S. and international R&D spending and management is *"not useful* for examining the current state and likely future of Army basic and applied research.*"* This is partly because U.S. and international S&T data do not distinguish between basic, applied, and technology development, and partly because the *quality* of basic and applied research is primarily a function of the "research environment," which goes beyond resource management to include qualitative aspects of a world-class culture of discovery among experts. This report demonstrates a methodological insight long-noted by science and technology policy scholars: *To understand what a world-class research environment entails, case studies are the better approach*. The report focuses on "benchmark labs" — Livermore and Bell Laboratories — and concludes, as a result, that "a pool of discretionary funds that amounts to 10-15 percent of lab budget" is a strong feature of the most innovative research environments. This insight is particularly powerful in light of Section 219 authority, which places only 3% of laboratory budgets into discretionary accounts, and the In-House Laboratory Independent Research (ILIR) program, which currently has a ceiling of 2.5% of 6.1 budgets. The report reiterates the 1983 Packard Commission recommendation that 5-10 percent of basic and applied research should go to a discretionary fund controlled by lab directors, along with *at least 5%* of 6.1 budgets for ILIR. Finally, the report supports the rapid expansion of Laboratory Demonstration projects (precursors to Science and Technology Reinvention Laboratory designation) for experimenting with alternative manpower and personnel concepts and policies.

Recommendations

Administration / Organizational Structure

- The Army-wide S&T resource database needs to be improved to support timely analysis and decisions for sound policy, strategy, planning, and program defense and oversight.
- *At a minimum*, ARL should report directly to the commanding general of AMC
- Given the Army-wide nature of ARO, ARO should either 1) report directly to DASA(R&T) or 2) remain part of ARL except be under operational control of DASA(R&T). This is similar to how ARI is part of US Army Human Resources Command but under operational control of DCS, G-1.
- To establish a culture of discovery in basic research, Army should provide incentives for experienced researchers to take greater risk in new areas of discovery.

Budget

- The Army should keep In-House Laboratory Independent Research (ILIR) funding at or above 5 percent of the Army's 6.1 budget and execute it like the Laboratory-Directed Research and Development (LDRD) program at the DOE weapons labs, excluding taxing customers.
- The Army should increase the amount of discretionary basic and applied research funding allocated to the director of ARL to 5 to 10 percent of its total basic and applied research budget, *as recommended in the 1983 Packard report*. ARL should not have more than 50 percent of its 6.2 mission funding obligated for Technology Program Agreements (TPA) and Army Technology Objectives (ATO).

- Army should establish funding stability for basic research portfolio and restore a longer-term perspective for basic research planning.

Facilities & Equipment

- Army should develop and fund a Laboratory/RDEC recapitalization plan, including a recapitalization rate goal for each laboratory and RDEC that sustains capital stock and technical equipment at a level commensurate with world-class research facilities.

Personnel / Manpower

- DoD [not just Army] should institutionalize the Laboratory Demonstration personnel management system and seek direct local hiring authority for S&Es. Lab managers should fully leverage this system.
- Increase S&E bench strength in network and information S&T, where the biggest advances are likely to come.
- To improve S&E quality:
    - Exploit internships, coops, post-docs, researcher mobility across budget categories, training, exchange, and collaboration arrangements with industry and academia.
    - Improve S&E field training with operational units
    - Improve mentoring junior and new S&Es
    - Promote external recognition of staff by encouraging patents, publications, and professional society fellowships.

Public Relations

- ARL should task a panel of distinguished scientists and engineers from outside the Army to identify the top 20 most important research inventions in the past 25 years from ARL (less ARO) and its predecessor organizations. This story should be captured in media suitable for distribution, to raise awareness among the R&D community in academia, industry, and government of the return on investment for ARL. This effort should be updated every five years.

National Academies of Science, *Determining Core Capabilities in Chemical and Biological Defense Science and Technology* (2012: HDIAC-2036836).

Summary

This report identifies which of the 39 core chemical and biological defense S&T capabilities can be found outside DoD laboratories (in academia, other government facilities, and industry), and which should be maintained, in whole or in part, by DoD in-house laboratories. Its recommendations relate to overall Chemical Biological Defense Program management and to provision of those in-house capabilities.

Recommendations

Administration / Organizational Structure

- DASD(CBD) should:
    - Lead a mission and strategy development activity that aligns all of the program elements and offices of the Chemical Biological Defense Program
    - Establish an effective "test watch and adopt" component within the CBDP to bring innovative solutions to ongoing needs, to include:
        - Mechanisms for searching and identifying relevant breakthroughs in the literature and from the private sector;
        - Mechanisms and processes in place for incorporating innovation into the ongoing program for the capability needed; and
        - Processes for rapid adoption of 'tweaks' that would significantly improve existing capabilities.
    - Survey the military laboratories and associated facilities to identify strong relationships between S&T performers and the warfighters, and support replication of such interactions across the program
    - Give priority to the active development and production of realistic and relevant threat agent simulants for both outdoor and large chamber tests (because of economic, logistical, and environmental concerns with actual agent testing)
    - Evaluate alternative program management approaches, including incorporation of an end-to-end project management authority, especially for the medical countermeasures program
    - Formally review alternative laboratory management models, taking advantage of the numerous prior studies, reviews, and evaluations of laboratory and large facility management of S&T organizations, in order to define the level of stewardship that the program should provide to the principal RDT&E in-house facilities and laboratories.
    - Implement a nested review process for chemical and biological defense RDT&E bound by consistent standards of rigor, frequency, and reporting
- DUSA(T&E) should require that:
    - T&E activities be based on testing protocols that accurately emulate actual operating environments (both threat properties and operator employment); and
    - Independent reviews of testing protocols be conducted

Budget

- OSD (through ASD(NCB)) should evaluate a shift from requirements-driven to capabilities-based planning, as a more appropriate approach for the CBDP
    - Planning should expand the range of options considered
    - Iterative review and realistic red-teaming should challenge assumptions built into plans
    - Overall S&T focus should shift from ‘zero casualties’ to ‘mission success’

University / Industry / Service Interaction

- Director, JSTO-CBD, should ensure that the development of a Culture of Collaboration is a high priority for all elements of the chemical and biological defense enterprise.

Kay S. Faith, *Patterns of Creation and Discovery: An Analysis of Defense Laboratory Patenting and Innovation,* RAND Graduate School (Santa Monica CA: 2013).

Summary

This public policy analysis dissertation compares patent trends (sorted by technology class) at individual DoD in-house laboratories (obtained from the DoD TechMatch list) with organizational features of those laboratories. The goal is to develop a reliable indicator of research quality useful for policymakers and S&T policy scholars. It contributes to RAND's statistical 'network approach' to patent analysis that maps laboratory patent activity onto broader technology maturation "s-curves."

Recommendations

Administration / Organizational Structure

- DoD staff and managers at government laboratories can use a network approach to detecting emerging technologies – insofar as the laboratories' mission, culture, and practices are reliably assessed through patenting patterns – in order to:
    - Identify innovative research projects
    - Monitor changes in laboratories' core competencies over time
    - Identify duplicative research activities across laboratories within technology classes
    - Conduct open-source intelligence on foreign and domestic R&D portfolios
    - [Enhance technology transfer / technology transition initiatives]
    - [Identify and reward innovative laboratory personnel]
    - [Exploit discretionary budget authority to adapt R&D portfolios in light of domestic and international research trends]

Institute for Defense Analyses, *Federal Security Laboratory Governance Panels: Observations and Recommendations* (January 2013: ADA581271).

Summary

This report focuses on the relationship between laboratory governance structures and laboratory operations and performance. Recommendations to 1) rationalize oversight burdens, 2) reinstitute laboratory flexibility for research budgeting, and 3) increase autonomy and accountability in personnel systems are made in response to personnel issues, competition from foreign R&D entities, changes to research focus and funding, and increased regulatory requirements and oversight.

The report notes: "Similar recommendations can be found in other reports produced in the past two decades, though…few implementation actions have been taken to date." In truth, these recommendations are among the most consistent recommendations found in reports going back *sixty* years, i.e. these are perennial laboratory governance and public administration issues.

Recommendations

Administration / Organizational Structure

- Standardize audit and regulatory practices according to similarity of laboratory *type*, for example by following International Organization for Standards practices
- Lengthen the tenure of laboratory directors to allow them time to implement strategic visions
- Increase In-House Laboratory Independent Research program budgets

Contracting

- Establish a strategic Work For Others plan to formalize difficult research portfolio decisions
- Increase use of CRADAs, Material Transfer Agreements, Facility Use Agreements, and WFO agreements

Facilities / Equipment

- Use Section 219 authority to the fullest extent possible, in order to reverse the "atomization of research budget oversight"

Manpower / Personnel

- Increase personnel exchanges through expanded use of Intergovernmental Personnel Act to facilitate mutual understanding and build trust for collaborative innovation
- Expedited security clearance processes for highly qualified S&Es
- Increased lab director autonomy to implement promotions and raises, or demotions and pay cuts
- Expand Laboratory Personnel Demonstration Projects
    - [This is among the most common recommendations during the 2010-2015 period, incorporated into DoD's current Science and Technology Reinvention Laboratory concept]

Education

- Expand and formalize student recruitment and retention programs

University/Industry/Services Interaction

- Increase partnerships with universities for faculty rotations to Federal laboratories and lab personnel rotations to university laboratories.

Institute for Defense Analyses, *A Study of Facilities and Infrastructure Planning, Prioritization, and Assessment at Federal Security Laboratories (Revised)* (February 2013).

Summary

This "descriptive snapshot" of 5 FFRDCs, 1 UARC, and 4 GOGO laboratories (DoD / DHS / DOE): identifies challenges in funding sources, planning and prioritization, stakeholder involvement and communication, and data / metrics that negatively affect Facilities & Infrastructure at "Federal security laboratories"; lists strategies currently used to address the challenges; and identifies five next steps for "Executive actions" that would improve these strategies.

Recommendations

Administration / Organizational Structure

- Establish an OSTP-led interagency subcommittee of National Science and Technology Committee for sharing F&I best practices, including master planning, data standardization, benchmarking, and external reviews – particularly best practices related to alternative financing for projects costing over $4 million.
- Establish a Task Force to assess revisions to OMB Circular A-11
- Issue an Executive Order or Presidential memorandum explicitly encouraging use of alternative financing for F&I
- DoD could publish a guidebook describing steps necessary for approval and implementation of alternative financing under existing rules and authorities
- DoD staff expressed the need to develop a coalition among their laboratories to better communicate their R&D asset needs to agency-level decision makers. For example:
    - Since rapidly advancing technologies in fields like micro-electronics require rapid procurement of new capital assets, for example, how can DoD laboratories communicate their *mission-critical* R&D needs to F&I program evaluators if there is no process for determining how much that uniquely scientific problem should affect weighting and prioritization alongside hospital construction, housing, schools, or other installation buildings? These issues need to make their way into *business plans* that present the F&I project to decision makers.
- Weighting mechanisms for F&I prioritization need to be systematically revisited
    - The most widely used F&I metrics do not link asset condition to asset capability, or quality to functionality. **As a result, existing F&I project assessments permit 'state-of-the-art' facilities to become obsolete** -- e.g. "The Facility Condition Index only tells you the basic structural capability of a building, but not whether it has the right hoods or the vibration level you need to do science."

Budget

- Congress or agencies could raise monetary limits on Section 219 or Laboratory Revitalization Demonstration Program
- R&D-specific MILCON authorities could be provided, so that R&D MILCON no longer competes with hospitals, schools, housing, and other installation buildings in existing F&I prioritization processes.

Paul N. Barnes, “Making Department of Defense Basic Research Purple (Joint), but NOT the Department of Defense Laboratories,” Army Research Lab (Adelphi MD: December 2013).

Summary

This report attempts to recycle recommendations found in official reports from 1989 to 2012 regarding centralized basic research planning. Notably, however, many of the recommendations the author cites from these previous reports were not actually endorsed by the authors of those very same reports. For example, a JASONs report from 2012 explaining the pros and cons of centralized ‘purple’ management of basic research called the drawbacks of such a plan (namely, long-term disconnection of basic research from Services’ needs) “a danger.” In the end, Col. Barnes brings attention to the possibility that such negative consequences could be mitigated by proper management.

Recommendations

Administration / Organizational Structure

- DOD should separate basic research management from the Services, forming a centrally managed DoD joint laboratory system. This represents “a complete cultural change and may place the leadership and subordinates temporarily in turmoil.”
    - Aggressive approach to implementation:
        - Integrated Process Teams composed of DoD-level and service RDT&E Executives would (through ASD (R&E)) centrally manage basic research programs by providing funds to Centers of Excellence (COEs), which would have various governance options to perform their mission (GOCO, GOGO, etc)
    - Radical approach to implementation:
        - COEs established within a central laboratory system overseen by a single Office for Basic Research, with a DOD Research Laboratory [presumably with many laboratory units, like AFRL] that manages and executes all basic research for DOD. Services would lose control of basic research management.

Institute for Defense Analyses, *Research Collaboration Between Universities and Department of Defense Laboratories* (July 2014).

Summary

This report addresses OSTP's goal of expanding and streamlining collaborative research partnerships between DOD laboratories and universities. Recommendations are provided alongside the challenges/considerations those recommendations are designed to address, i.e. "The What" and "The Why" are listed side-by-side.

Recommendations

Administration / Organizational Structure

- DOD laboratories and universities should increase outreach events, particularly those including targeted, research-based discussions between laboratory staff and faculty.
- DOD laboratories should provide greater clarity to the academic community on "rules of the road" for collaborating with the DOD and with specific laboratories. DOD laboratories should increase awareness and publicity of funding announcements, and encourage universities to consider engaging in collaborations where their research overlaps with a DOD funding opportunity.
- DOD laboratories should develop clear paths for resolving security and classification restrictions, and increase university researchers' understanding of the motivation for those restrictions.
- To overcome perceptions of legal, ethical, and security restrictions for collaboration, DOD should provide guidance to in-house researchers and should circulate memos that clarify existing restrictions and encourage collaboration

Manpower / Personnel and Facilities

- DOD laboratories should explore creating partitioned, unclassified work spaces to facilitate collaboration.
    - [Official reports have been attempting to deal with the recruitment issue of making space for new employees, summer interns, and university students to conduct unclassified research since at least DDRE's June 1969 Office of Laboratory Management study, "Joint Program of the Civil Service Commission and the Department of Defense to Resolve Problems in the Management of Defense In-House Laboratories"]
- To overcome the lack of a general agreement framework for new research cooperation, DOD laboratories and universities should seek out Memoranda of Understanding to clarify the bounds of relationships and enable future work.

University/Industry/Services Interaction

- To increase interpersonal connections among lab personnel and universities:
    - Expand personnel exchanges;
    - expand support for seed grant programs for first time researchers or universities that have not previously partnered with DoD;

- expand student programs and post-doctoral fellowships;
- clarify rules for sending lab personnel to conferences

Technology Transfer

- DoD laboratories and universities should consider proposing *a legislative solution* to the issue of patent filing fees through the Interagency Working Group on Technology Transfer, because collaborating with Federal agencies causes universities to lose their micro-entity status for filing patents (as created in the America Invents Act).

Government Accountability Office, *Defense Science and Technology: Further DoD and DoE Actions Needed to Provide Timely Conference Decisions and Analyze Risks from Changes in Participation* (March 2015: ADA614349).

Summary

This report examines DoD's current three-tiered system for approving attendance at conferences, both sponsored by DoD and not sponsored by DoD. Budget cuts, OMB rules, and a 9-month approval process caused overall conference attendance requests to decline by 50-90% in many DoD labs from 2012 to 2013. DoD has agreed to pursue further studies as a basis for making improvements to its procedures.

Recommendations

Further Studies

- DoD reports that it will collect and validate data on administrative processes to approve S&E travel to conferences, and will analyze the data to determine root causes of declining conference attendance.
    - The above is in response to GAOs recommendation: **"**To help manage the risks from changes in conference participation and any potential effects on the defense S&T enterprise, the Secretary of Defense should direct the Assistant Secretary of Defense for Research and Engineering, in consultation with the Office of the DCMO, to develop a plan to analyze and periodically reevaluate the risks from changes in participation at S&T conferences for any potential effects on DOD's ability to meet its scientific mission, including identifying and collecting additional information needed to conduct this analysis."
- DoD concurs with GAO Recommendation**:** "To help provide more timely decisions to those seeking to participate in conferences, as part of DOD's and DOE's ongoing streamlining efforts to reduce the length of their conference review and approval processes, the Secretary of Defense should direct the Secretaries of the military departments, in coordination with the Office of the Deputy Chief Management Officer (DCMO), to establish time frames for providing conference review and approval decisions based on applicants' needs."

Endnotes

[i] J. Erik Hazell, "From Reform to Reduction: Reports on the Management of Navy and Department of Defense Laboratories in the Post-Cold War Era," (A Joint Publication of the National Defense University and Naval Historical Center: 2008): 23.

[ii] Donald M. MacArthur, "Effective Use of Federal Laboratories," Office of the Director of Defense Research and Engineering (April 1968: AD0668344).

[iii] Defense Science Board, "Report of the Task Force on Defense Laboratory Management," (1994): enclosure 1, p.1.

[iv] Barry Bozeman, "A Theory of Government 'Red Tape'," *Journal of Public Administration Research and Theory Vol. 3 Issue 3 (1993): 273-304.*

[v] JASON, "S&T for National Security," Released 13 May 2010 to the Federation of American Scientists following a FOIA request and appeal to the DoD (2008: ADB360036); Don J. DeYoung, "Breaking the Yardstick: The Dangers of Market-based Governance," *Defense Horizons* (May 2009: ADA499585).

[vi] Defense Science Board, "Technology Capabilities of Non-DoD Providers of Science and Technology, Systems Engineering and Test and Evaluation," (June 2000): ADA380423.

[vii] Hazell 2006; JASON 2008; DeYoung 2009; Richard Chait, "Perspectives from Former Executives of the DOD Corporate Research Laboratories," National Defense University (March 2009: ADA496468).

[viii] Defense Science Board, "Report of the Defense Science Board 1981 Summer Study Panel on the Defense Technology Base," (1981).

[ix] DeYoung 2009: 133; Institute for Defense Analyses, "A Study of Facilities and Infrastructure Planning, Prioritization, and Assessment at Federal Security Laboratories (Revised)," (IDA Science and Technology Policy Institute: February 2013): 72;

[x] Personal communication with J. Art Hagler, Director, HQDA Logistics Resource Management (G-48), January 2016

[xi] Defense Science Board, "Report of the Task Force on Defense Laboratory Management," (1994)

[xii] Fortunately, the Force of the Future initiatives of current Secretary of Defense Ashton Carter, designed as they are to increase the quality of life of DoD (laboratory) personnel, should have positive effects on the "culture of discovery" by making laboratory environments more psychologically hospitable.

[xiii] Arthur D. Little, Inc., *Management Factors Affecting Research and Exploratory Development, 1962: I-15.*

[xiv] John L. Allen, Rodney E. Grantham, and Donald B. Nichols, *The DoD Laboratory Utilization Study,* (Office of the Director of Defense Research and Engineering: 28 April 1975, ADA012660).

[xv] Personal communication with ASD (R&E) Director for Basic Research, Dr. Robin Staffin, May 2016.

[xvi] Personal communication with ASD (R&E) Director for Laboratories, Dr. Jagadeesh Pamulapati, June 2016.

[xvii] Matt Hourihan and David Parkes, *Guide to the President's Budget: Research & Development FY 2017*, (American Association for the Advancement of Science: 2016), 19.

[xviii] One might assume that the initial 50% reduction in ILIR program spending from previous years is explained by several factors, such as the addition, in 2009, of Section 219 authority, providing 3% of total laboratory budgets for discretionary spending that can include R&D projects, or the addition, in 2002, of a mirror program for the 6.2 budget, known as In-House Applied Research (IAR). This latter development could conceivably cause ILIR projects that are more nearly 'applied research' to migrate to IAR, opening new space for basic research proposals. On this view, the ILIR budget has diminished in importance over the decades because plenty of other funds have become available for producing basic research. However, documentary evidence demonstrates that draft versions of DoDI 3201.4 from 2010 would have provided 5% of the 6.1 budget for ILIR and 5% of the 6.2 budget for IAR. This would seem to indicate that some substantive policy analysis process was conducted to determine that a 2.5% ceiling was better than a 5% ceiling. Based on information obtained from informal interviews of personnel involved in the DoDI 3201.4 policy process, however, no such substantive analysis was actually conducted.

One could also suppose that fiscal restraints have placed an incentive on budget programmers to reduce ILIR programming as a way of justifying budget *increases* to other programs. It is important to discover if this is in fact the case. 70 years of official government reports from some of the world's greatest R&D planners have cautioned against a diminished appreciation for the long-term necessity for revolutionary basic research. The best ideas for research are often unpredictable, and discretionary funds are a way to seize the window of opportunity on such ideas. In short, there is a gap in our institutional knowledge of what is happening with the ILIR program, and how to maximize its potential.

[xix] Federal Council for Science and Technology, *Competition for Quality* (Astin Report) (1962): Vol. II, 5

[xx] Oddly, rather than complete Project REFLEX as initially intended and rigorously measure the results, which would distinguish between the variables in question (manpower ceilings vs. fiscal controls), DoD expanded the project to additional laboratories before the pilot program was completed.

[xxi] Office of the Director of Defense for Research and Engineering, *Allocating Work, Funds, and Manpower to Department of Defense Laboratories* (1969: AD0889192); Office of the Director of Defense Research and Engineering, *Joint Program of the Civil Service Commission and the Department of Defense to Resolve Problems in the Management of Defense In-House Laboratories* (June 1969: AD0694449); Director of Navy Laboratories, *A Plan for Improving the Effectiveness and Utilization of the Navy's In-House Labs* (Lawson Report) (25 May 1971: ADA555255); John L. Allen Rodney E. Grantham, and Donald B. Nichols, *The DoD Laboratory Utilization Study,* (Office of the Director of Defense Research and Engineering: 28 April 1975, ADA012660); Deputy Undersecretary of Defense for Research and Engineering (Research and Advanced Technology), *Removal of Institutional Barriers on DoD Laboratories* (September 1979: ADA102544).

[xxii] The following list of study types is compiled from a survey of the FY17 DOD Justification Book.

[xxiii] Defense Business Board, April 2010, *Optimizing the Electronic Management of DoD-Related Studies*, DTIC, ADA526146

DBB personnel briefed then-USD (AL&T) Dr. Ashton Carter on this plan to design "ATHENA", a fully searchable knowledge management architecture capable of extracting basic meaning from all DoD-produced or DoD-relevant DTIC technical reports, government reports, in-house studies, domestic and international academic and think-tank articles and reports, and foreign military capability assessments. To my knowledge, the concept has not been revisited in official studies since 2010, despite notable improvements in natural language processing and semantic analysis. DTIC recently launched a Boolean searchable interface, CroSS, which this author utilized in the study that follows; but this modest capability does not nearly fulfill DBB's stated vision.

Thanks are due to Phyllis Ovsiew and Carol Jacobsen from DTIC for their assistance in utilizing CroSS for present research purposes.

[xxiv] David H. Guston, "Critical appraisal in science and technology policy analysis: The example of *Science, the Endless Frontier*," *Policy Sciences 30 (1997): 233-255.*

[xxv] Ibid